# *Mortuary Treatment, Pathology, and Social Relations of the Jiahu Community*

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## INTRODUCTION

ALL SOCIETIES EMPLOY SOME REGULAR PROCEDURES or set of procedures for the disposal of the dead (O'Shea 1984:33). Mortuary data, therefore, are invaluable information for the reconstruction of many aspects of past societies. However, funeral ritual is a projective symbolic system because the link between the funerary treatment received by a deceased individual and the social status of that individual when living varies from society to society. Efforts to monitor the social relations among the dead based on the mortuary data alone may generate biased interpretations.

To mitigate this ambiguity, we can rely on analysis of human bones, which are sensitive to the environment. Factors such as diet, disease, and mechanical stress leave indelible marks on the bones. Therefore, bones provide excellent records of the interaction between the environment and behavior in an individual's lifetime. However, if we are content answering questions only of health and lifestyle with the osteological data, we miss the opportunity to elucidate the underlying social factors that generated the osteological pattern in the first place.

This article is an exercise in creating a dialogue between the analytical results of the study of mortuary treatment of the deceased and the pathological study of the human skeletal remains. We will demonstrate that mortuary data and pathological data are two independent but complementary classes of information. When used together they can generate constructs of the past richer than can be generated with either body of evidence alone. The hybrid methodology proposed in this paper has general applicability to the archeological studies of past societies based on materials recovered from human burials.

The archaeological case under study is the human burial assemblage of Jiahu in central China, an early Neolithic site dated to the seventh millennium B.C. We follow the strategy that a comprehensive study of mortuary practice is first conducted and the results are interpreted. The mortuary pattern is then evaluated by the pathology documented on the skeletal remains. Although much has been

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gained in the understanding of the social relations of the Jiahu community through the systematic analyses of mortuary variation, two findings in the light of the pathological study are particularly intriguing.

First, we have isolated a small group of individuals who had been treated with outstanding material wealth by the Jiahu standard. Many archaeologists would interpret them as prestigious individuals, yet their bones bear more symptoms of poor health pertaining to a high-grain low-meat diet than the non-prestigious or common individuals. Greater burial good wealth, therefore, does not have a direct relationship, and can even have an inverse relationship, to the foodways of the individuals as living members of the community.

Second, we have also determined that the females as a group were not treated as well as the males in the burials, indicating sex was one of the factors regulating the mortuary practice of Jiahu. The bones of the females had a lower frequency of mechanical stress–related diseases, indicating that they played a daily role different from that of the males. A sexual division of labor was the likely attribution of the sex-based differential burial treatment. Moreover, the female remains show that they suffered less frequently from iron-deficiency anemia than the males. Playing a less physically strenuous role in the community did not seem to hinder the females in acquiring a more balanced diet.

## MORTUARY DATA AND SOCIAL ORGANIZATION

Mortuary data are one of the most common classes of information recovered from archaeological sites. This invaluable source of information is particularly useful in the reconstruction of past societies. Yet, the social position of an individual is not necessarily directly reflected by the mortuary treatment received by the individual upon death. There exists a potential danger of misinterpreting a past society based on mortuary data alone.

The systematic study of mortuary practices of past societies in archaeology started in the 1970s. The first generation of mortuary studies was inspired by the seminal works of Saxe (1970), Binford (1971), and Brown (1971). These studies maintain that mortuary differentiation does not vary independently of the organization of the society, thus allowing a linkage between the mortuary treatment received by an individual and the social position of that individual as an active member of the society. They are optimistic that based on mortuary data alone, archaeologists can reconstruct the underlying structural principles of past societies (Brown 1971; Chapman 1981; Goldstein 1981; Milner 1984; Peebles 1971; Tainter 1977). The optimism of the seventies met its challenge as some empirical studies of the historical period indicate that differentiation in burial treatment does not directly correspond to social status of the deceased (O'Shea 1984; Parker Pearson 1982; Randsborg 1981). In other words, rich and elaborate graves do not necessarily equate high social status (Cannon 1989; Little et al. 1992); or conversely, people buried in unfurnished graves may not necessarily be lower ranking individuals (Arnold and Green 2002).

First and foremost, all mortuary analyses are based on incomplete pictures of the funeral rites that produced the archaeologically observable mortuary patterns. The grave is only one of several contexts in which bodies and offerings are deposited. Consequently, what archaeologists dig up in graves are the remains of one of

several phases of the funeral rite. Since a funeral rite has several parts and inhuming is only one of the components, elaboration could have occurred in the other phases of the rite. In addition, many cultures practice cremation that destroys most of the offerings. Key possessions may have been withheld from burial and burned during the mourning ceremony, which is held separately from the inhuming process (Arnold and Green 2002). Moreover, not all skeletal elements were disposed in the graves. For instance, in the third millennium B.C. in the British Isles, there are good empirical grounds for arguing that the body parts of some individuals circulated between tombs and communities (Chapman 1995). O'Shea (1981, 1984:28) points out quite correctly that mortuary distinctions observed by archaeologists communicate a limited subset of the social differentiation of the living society, which has been filtered through the processes of mortuary symbolism, change in disposal unit, and post-depositional effect. Therefore, to infer the social relations among the dead based on burial information alone is potentially ambiguous.

More importantly, the link between mortuary treatment and social position varies through time and space. If funeral practice is viewed as a medium for the competitive expression of status and status aspirations, we must accept the fact that effective display—that is, the ability to draw attention and communicate a distinct message—through elaboration would dwindle when it is rendered redundant through a multiplicity of competing and emulating forms (Cannon 1989). The result is the abandonment of mortuary elaboration in favor of simple forms of disposal, first by the wealthiest and most influential members of the societies, and then gradually by lower social levels. Parker Pearson (1982) reports that in Victorian Britain the most expensive funeral and monumental practices were those of the Gypsies, social outcasts, whereas the well-to-do and educated Britons favored cremation. Cannon (1989), based on studies of British, Iroquoian, and Greek societies, further argues that there existed a cycle of increasing ostentation and subsequent restraint on mortuary practices analogous to fashion shifts.

It should be clear that funeral rituals are strategic engagements through which people reproduce the conditions of the living. The employment of funeral symbolism, therefore, does not simply concern the proper treatment of the dead, it also concerns the reallocation of rights and duties among the living (Barrett 1990:182; Flad 2001). Attention thus shifts from attributes of the dead to the social construction by the living (Brown 1995). In this regard, forms of funeral practices are actively chosen by social actors in connection to specific social relations and beliefs, rather than a direct reflection of social status of the deceased (Kuijt 1996). Factors such as power relations, ideology, religion, and the malleability of social categories (contrary to the role theory subscribed to in the Binford-Saxe model) are important in the creation of the funeral domain (Arriaza et al. 2005; Carr 1995; Charles 1995; Gamble et al. 2001; Hallote 2002; Hodder 1984; Macdonald 2001; Parker Pearson 1982, 1999; Rainville 1999; Tilley 1984, 1995). Funeral rituals not only can solidify existing social relations, they also can do the contrary, that is, idealize and mask daily relations.

We have so far concentrated on the bigger picture of the social implications of mortuary differentiation. In fact, each funeral is designed for the deceased by the living, most likely the surviving relatives, or commissioned by the surviving rela-

tives to the ritual specialists. The factor of sentiment also must have been involved in the formula of treatment. Subadults in many societies in which social hierarchy is absent are associated with significant "wealth" (O'Shea 1996). This may represent the great sadness at the loss of a child who has not had the opportunity to live a full productive life (MacDonald 2001), or it may represent gifting by community members related to the grieving parents (Carr et al. 2006). Wealth with child burial, therefore, does not necessarily equate status ascription (contra Peebles and Kus 1977). Facing the emotional crisis of losing a member of the group, many cultures treat funeral practice as the venue through which the living maintain their relationship with the dead (Porter 2002). Because all funerals are exposed to the public eye, private sentiment has the potential to be transformed into a ritualized public ceremony. In nineteenth-century Western culture, the spontaneous emotional expression of grief was regarded as a civic virtue, and therefore subjected to intensive scrutiny by the neighbors (Little et al. 1992).

It should be clear by now that mortuary practices are complex representations of the society (Porter 2002). In addition to social factors, important factors that may regulate a mortuary institution include ideology, religion, and sentiment. There are many ways archaeologists can be misled if they simply equate the differential distribution of artifacts in cemeteries with the status differentiation of the deceased and the greater social organization (Gamble et al. 2001). The link between mortuary treatment and social status is variable. Some societies have direct corresponding relationships, whereas some societies have asymmetrical or "inverse" relationships. Archaeologists interested in using mortuary data to monitor the structural principles of past societies are in dire need of information independent of the burial practice. Human bones recovered from burials are an excellent source of information to complement the patterns extrapolated from the mortuary context and provide criteria for the selection of alternative interpretations conducive to the mortuary pattern.

## HUMAN BONES AND SOCIETY

Many diseases have social causes. The human skeletons recovered from archaeological sites not only can tell us about the health of a past population, they can also tell us about the society, especially when the pathological pattern is viewed in the context of differential mortuary treatment.

The human skeleton documents the interaction between the environment and behavior in an individual's lifetime. Many conditions of diet, disease, trauma, and mechanical stress leave indelible marks on the bones. Given that mortuary practice is often used to mask daily social relations, the skeletal remains recovered from archaeological sites are an independent source of information that can test the interpretation of the burial treatment pattern.

A number of biological and pathological conditions are readily observable from the human skeleton. These conditions, which are good indicators of health, can be useful in understanding the differences in both the vertical and horizontal social distinctions in society. In the present study, we concentrate on chronic infectious disease, iron-deficiency anemia, and degenerative joint disease. The criteria used for sex identification focus primarily on the pelvis, skull, and postcranial

long bones (Bass 1995; Buikstra and Ubelaker 1994). These methods are not 100 percent accurate and are more imprecise for younger individuals. Individuals with ambiguous sex were not used in the relevant analyses.

Many infectious diseases, including bacterial infection and parasitic infection, would cause nonspecific bone lesions that are collectively called periosteal reactions (Armelagos et al. 1991; Lallo et al. 1977). From an evolutionary perspective, a sedentary lifeway is more susceptible to infectious disease than a foraging lifeway (Armelagos et al. 1991; Larsen 1984, 1995). Sedentary conditions, often associated with an increase in local population density, promote the spread of contagious diseases, particularly as a function of poor hygiene and sanitation (Larsen 1995). A number of empirical studies indicate that the increase of sedentism among human groups often corresponds with the increase of periosteal reaction (Angel 1984; Buikstra and Williams 1991; Cassidy 1984; Cook 1984; Goodman et al. 1984; Lallo and Rose 1979; Larsen 1994, 1995; Meiklejohn et al. 1984; Perzigian et al. 1984; Rose et al. 1991; Ubelaker 1994). Poor nutrition and anemia are also cited as causes of periosteal disease (Cohen and Armelagos 1984; Eisenberg 1991; Larsen 1995; Milner 1991; Milner et al. 1991). Because people with poor health and weakened immune systems are more vulnerable to infectious diseases, differential distribution of periosteal reaction in a sample population may have implication for the differential access to a balanced diet.

Symptoms of periosteal reactions, that is, lesions on human skeletons, are readily observable with the naked eye. The image in Figure 1 shows the marks left by periosteal reaction.

Anemia is a common blood disorder caused when there is a lower than normal number of hemoglobin in the blood. This can cause a variety of health problems because hemoglobin carries oxygen to the body's tissues. Anemia has myriad causes; these include disorders of the blood system (genetic or otherwise), exposure to toxins, kidney failure, parasitic infection, deficiency of iron intake, etc. (Garn 1992). Nevertheless, scientists have argued that iron-deficiency is the major behavioral agent causing anemia (Stuart-Macadam 1992). Furthermore, porotic hyperostosis, the lesions that are caused my anemia that occur in the skull vault, usually in the occipital, frontal, and parietal bones (Buikstra and Ubelaker 1994; Stuart-Macadam 1992), is most commonly caused by iron-deficiency anemia (Goodman 1994; Goodman et al. 1984; Stuart-Macadam 1992). Also, girls going through puberty are more susceptible to iron-deficiency anemia. The onset of menstruation increases the amount of iron intake they need. Pregnancy is also another condition in which iron-deficiency anemia can occur (Sullivan 2005).

A number of studies worldwide have documented that the transition from foraging to agriculture led to an increased rate of anemia among human groups (Angel 1966, 1978, 1984; Carlson et al. 1974; Cassidy 1984; Cook 1984; Goodman et al. 1984; Kennedy 1984; Lallo et al. 1977; Norr 1984; Perzigian et al. 1984; Rathbun 1984; Rose et al. 1984). Garn (1992) has outlined four basic facts in relation to the transition that contribute to iron-deficiency anemia. They are: (1) meat contains more iron than grain; (2) the iron present in meat is more easily absorbed than the iron present in grain; (3) meat contains compounds that promote iron absorption; and (4) many important grains such as rice and millet contain potential inhibitors of iron absorption. Farming groups' high-grain low-meat

Fig. 1. Example of periosteal reaction in the midshaft of the femur from the Shijia site (Yangshao tradition). (Photo courtesy Barbara Li Smith)

diet effectively elevated the rate of iron-deficiency anemia. Likewise, differential distribution of iron-deficiency anemia in a sample population is likely attributable to differential access to sources of animal protein.

Anemia is manifested in human osteology by lesions in the skull that occur in both the less dense middle layer and in the outer, compact layer. The characteristic lesions are produced by increased red blood cell production (as the body's reaction to anemia), which causes marrow cavity enlargement and reduced cortical volume (Garn 1992; Larsen 2002; Stuart-Macadam 1992). They form obvious physical characteristics on the skull (Fig. 2).

Degenerative joint disease, also known as osteoarthritis, is a disease that is characterized by the degradation of the cartilage and bone in and around joints (Bridges 1992; Larsen 1995). Although multiple factors can result in the development of degenerative joint disease, physical activity is the primary behavioral cause (Radin et al. 1972). Sustained and repetitive mechanical stress over an individual's lifetime is reflected in the prevalence, location, and severity of degenerative joint disease (Bridges 1992; Hough and Sokoloff 1993; Jurmain 1980; Larsen 1997). Because degenerative joint disease results from the wear and tear due to mechanical motion in the body, age plays a central role in the occurrence of the disease with older individuals showing higher incidence of disease (Stewart 1957,

Fig. 2. Typical example of porotic hyperostosis, specimen from the Shijia site (Yangshao tradition). (Photo courtesy Barbara Li Smith)

1958). The older an individual, the more likely he or she is to develop degenerative joint disease; therefore premature development of degenerative joint disease is indicative of unusual physical stress on the body. By the same token absence of the disease may indicate early age at death or a relatively mechanically stress-free life.

Osteoarthritis is mostly exhibited on the proximal and distal ends of the extremities (Fig. 3). The location of degenerative joint disease provides clues to the kinds of physical activity that caused excessive damage to the cartilage. Therefore, not only is the rate of osteoarthritis in different social groups important, the location of osteoarthritis can reveal the types of physically strenuous tasks the group was regularly engaged in.

Although infectious disease, iron-deficiency anemia, and degenerative joint disease are caused by a number of factors, social and behavioral factors are two major causes. Variations in social arrangement and behavior are conducive to statistical patterns in the pathology of a sample of human skeletons. However, the pathological data are seldom used together with the patterning of mortuary treatment in an integrated research scheme (see a recent example in Shimada et al. 2004). The goal of this article is to create a dialogue between the two different classes of information extracted from Jiahu, an early Neolithic site in China. The result is a fuller understanding of the social dynamics of a past society.

Fig. 3. Degenerative joint disease on the distal end of a femur from the Xinglongwa site (Xinglongwa tradition). Example of eburnation and polish. (Photo courtesy Barbara Li Smith)

## JIAHU COMMUNITY

The hybrid methodology proposed in this article is employed in the study of a burial sample recovered from Jiahu, in an effort to monitor the social dynamics that structured that community. Jiahu is an early Neolithic site of the Peiligang tradition (9000–7700 B.P.) located about 22 km north of the county seat of Wuyang, southwestern Henan Province, China. Geographically, the site situates on the southwestern edge of the North China Plain, in the transition region between the northern subtropical zone and the southern warm temperate zone. Between 1983 and 1987, the Henan Provincial Institute of Cultural Relics and Archaeology directed six seasons of excavation at Jiahu, opening an area of about 2360 $m^2$. The mortuary materials used in the present study came from the above fieldwork, which resulted in a two-volume technical report, *Wuyang Jiahu* (Henansheng Wenwu Kaogu Yanjiusuo 1999), detailing the findings. The following narrative of the site and its findings are based on the report, unless specified otherwise.

The oval-shaped site was a settlement occupied year-round, covering an area of approximately 5.5 ha (Fig. 4). The excavation covered only about 5 percent of the total occupation area and was concentrated on the western part of the site. The Neolithic deposition, 50 to 90 cm in thickness, can be partitioned into three strata, all yielding material remains diagnostic to the Peiligang tradition. The exis-

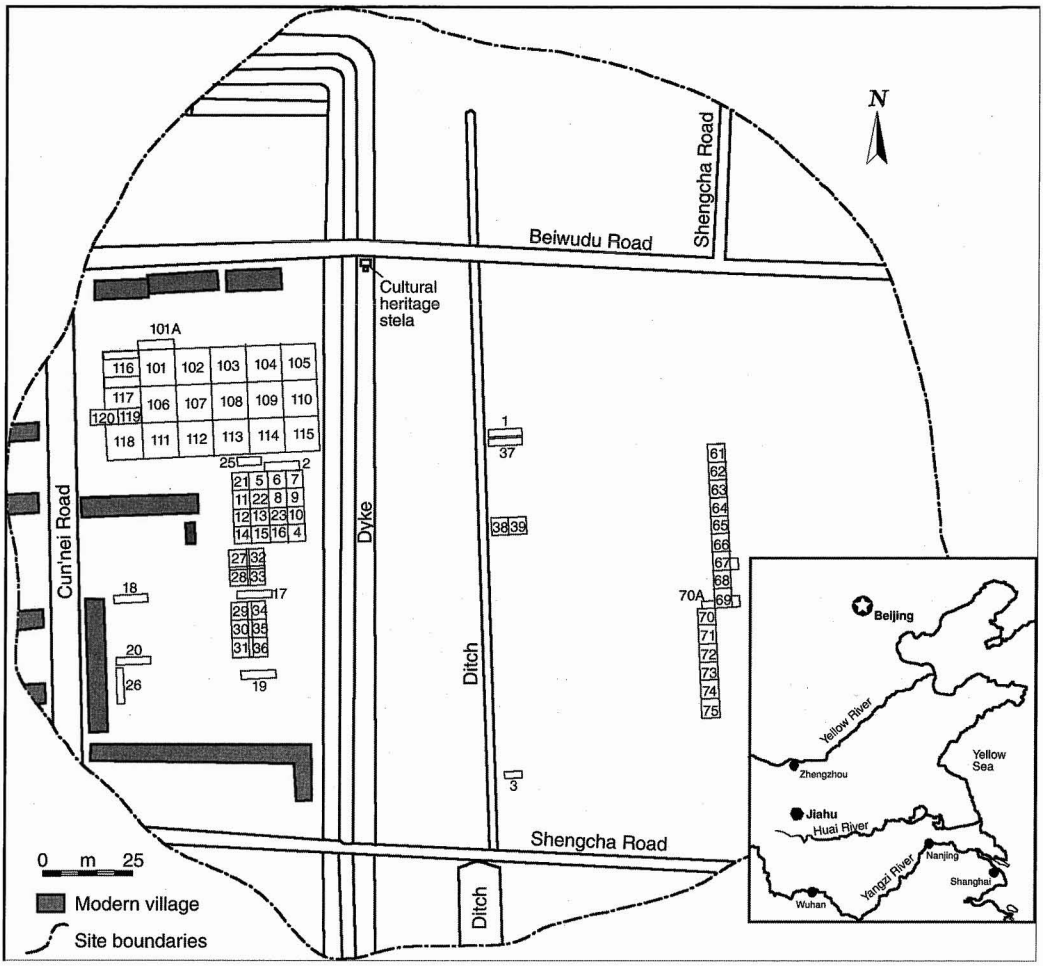


Fig. 4. Grids of the Jiahu site at Wuyang, Henan (redrawn after Henansheng 1999:16, Fig. 3).

tence of these three Neolithic strata suggests that this site was a favorable settlement location to which prehistoric people kept returning. Nineteen radiocarbon dates bracket the Jiahu Neolithic occupations between 7000 and 5800 B.C.

During the Neolithic, Jiahu was a sedentary community sustained by a broad-spectrum economy. The wet swampy environment in the immediate vicinity of the site could have supported diverse food procurement strategies. Macro-remains of carbonized rice grains and phytolith indicate that the cultivation of *japonica* rice provided the bulk of staple (Zhang and Wang 1998). The wide array of faunal remains and the great number of arrowheads and harpoons recovered suggest that the Jiahu subsistence was supplemented with animal domestication, hunting, and fishing.

The excavation at Jiahu uncovered 45 house features. However, identifying them in the field was quite difficult because of their small size, simple construction, and poor preservation. We suspect that the lack of features like hearths and

postholes might be responsible for the misidentification of some houses as ash pits. Most of the houses were small; fourteen of them were under 4 $m^2$ in area and 32 were under 10 $m^2$. (The calculation of house area is difficult because most of the occupation floors are not in regular geometric shapes. Our calculation is based on the maximum length times the maximum width, which would be a slight overestimation of the exact occupation area.) The majority of houses were semi-subterranean, single-chambered structures; however, eight of the houses were multi-chambered, with up to four rooms. The construction sequence of these houses indicates that new chambers were attached to existing houses.

Ash pits were numerous and densely distributed in the excavated area. About 400 ash pits were uncovered. They were circular or oval in shape. Some of the pit walls showed scars of digging tools, indicating that they were intentionally dug, most likely as storage cellars. Upon their abandonment, the cellars were filled with domestic refuse rich in organic material. Permanent facilities like houses and storage cellars suggest that the settlement was occupied year-round.

Excavation at Jiahu revealed a rich material culture. The ceramic, stone, and bone industries produced a great number of utilitarian tools. Among the most spectacular findings are flutes made of the ulnae of red-crowned cranes (*Grus japonensis,* Millen). Many of them are still performable and can play modern-day melodies, indicating the development of a musical scale (Wang 2002; Zhang and Lee 2005; Zhang et al. 1999, 2004).

Some bone objects bear incised insignias on the surface, suggesting a system of representation had taken hold (Li et al. 2003; Liu 2003). Other unusual artifacts include two-pronged bone implements (Fig. 5) and turtle shells containing peb-

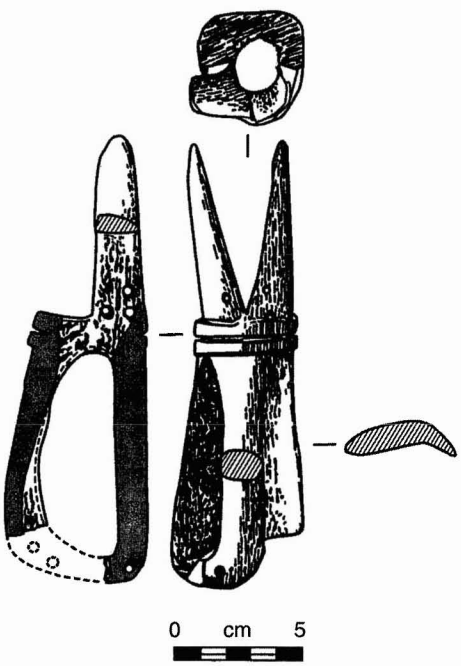


Fig. 5. Two-pronged bone implement (M395:2) of Jiahu (redrawn after Henansheng 1999:446, Fig. 317).

bles of various colors. The function and meaning of these artifacts have invited much speculation. Many argue that they were related to divination and shamanism (Henansheng Wenwu Kaogu Yanjiusuo 1999:976–977).

## BURIAL PROGRAM OF JIAHU

The excavations at Jiahu uncovered 349 earthen pit burials of juveniles and adults and 32 urn burials of infants, totaling close to 500 individuals. The Jiahu mortuary program was quite complex; upon the death of an individual, the funeral directors had to make a series of decisions. This section examines the traits of the Jiahu burial program by following the step-by-step procedures of a burial rite. We determine that the age and sex of the deceased, disposal area, orientation of the burial pit, number of interments in the grave, primary or secondary treatment, body posture, removal of skeletal elements, and quantity and quality of offerings were potentially important factors that might have significant sociocultural implications in the Jiahu community (Table 1).

Based on the surviving archaeological evidence, the first decision the funeral directors had to make upon the death of a community member at Jiahu was whether to inhume the deceased in an urn or in an earthen pit. Age apparently was the determining factor because only infants and young children were buried in urns. Most kinds of domestic vessels with wide mouths could be used as receptacles for infant bodies; these include *guan* (jar), *ding* (tripod cooking pot), *yan* (steamer), and *pen* (basin). The receptacles were usually covered with a *bo* (bowl) over the mouth.

The distribution of burial urns was non-systematic; they were found almost everywhere in the settlement area singularly or in small groups. The infant bones are so fragile that many have deteriorated to a light gray ash. In one place, an unerupted deciduous tooth was found in an urn. It is apparent that urn burials were used for newborns and young children of less than three to four years old. No grave offering have been found in these burial urns. It is likely that some infant burial receptacles were not identified in the field because of the lack of skeletal material. The following study excludes the urn burials from the osteological analyses because of these difficulties.

TABLE 1. DECISIONS OF DIFFERENT STAGES OF THE JIAHU BURIAL RITE

| DISPOSAL FACILITY | DISPOSAL LOCATION | PIT ORIENTATION | INTERMENT TYPE | BODY POSTURE | BURIAL GOODS |
|---|---|---|---|---|---|
| Pit grave (adult + children) | Disposal area | East–west<br>Deviated orientation | Primary<br>Secondary | Extended supine<br>Prone<br>Bundle re-articulated | Quantity<br>Quality |
| | | | Single multiple element removal | | |
| Urn (infants) | No spatial pattern | | | | No burial goods |

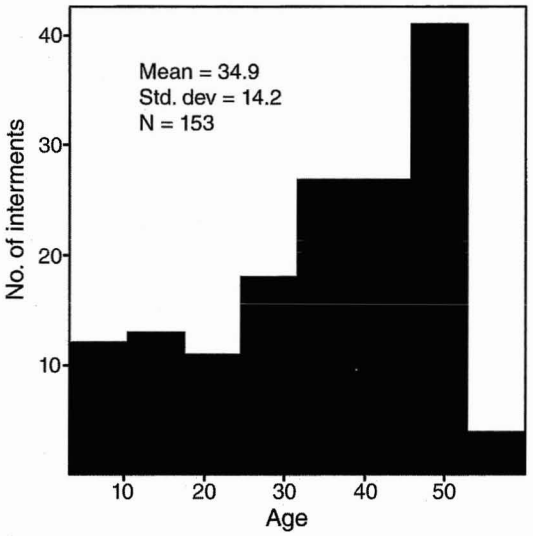


Fig. 6. Age distribution of the interments of Jiahu pit burials.

If an earthen pit burial was chosen, the funeral directors had to decide where to dig the grave. Some children as young as three to four years old were buried in earthen pit graves. The distribution of the 153 interments identified by approximate age indicates that a fair number of subadults under the age of 20 (13.1%) were inhumed in earthen graves (Fig. 6), but the majority of the interments were those of mature and old adults. Both sexes were disposed of in earthen graves, although it was heavily biased against females. Females comprise a mere 36 percent of the total interments whose sex can be identified.

The Jiahu earthen graves were apparently organized into several spatially discontinuous formal disposal areas (Table 2). Phase I pit graves were either located in a northern area or a southern area. The distribution of the pit graves of phases II and III show significant overlap. The borders of many of the disposal areas have

TABLE 2. DISTRIBUTION OF BURIALS BY DISPOSAL AREA, JIAHU

| PHASE | AREA | GRID UNITS | NO. BURIALS |
|---|---|---|---|
| I | Ya | 5, 9, 21, 22, 25, 104, 105, 109, 113, 114 | 26 |
| | Yb | 4, 14, 15, 16, 17, 27, 28, 33, 35, 36 | 16 |
| II | Ea | 101, 101A, 102, 116 | 78 |
| | Eb | 6, 7, 8, 9, 10, 16, 23 | 55 |
| | Ec | 17, 27, 28, 33, 34, 35 | 15 |
| | Ed | 110, 115 | 5 |
| | Ee | 1, 37 | 7 |
| | Ef | 71 | 4 |
| III | Sa | 101, 102, 116 | 68 |
| | Sb | 6, 7, 8, 9, 10, 16, 23 | 36 |
| | Sc | 17, 27, 28, 33, 34, 35 | 15 |
| | Se | 1, 37 | 17 |

not been found (they have not shown spatial discontinuation), suggesting they might comprise more burials than what were revealed by the excavation. In addition, three burials were isolated in grid units 18 and 113. They may represent other formal disposal areas yet to be uncovered. Within each disposal area, the distribution of graves could be extremely dense. Figures 7 and 8 show the distribution of graves in areas Ea and Eb during phase II. It is common that four to five burial pits overlap and cut into one another. Apparently, the disposal areas were culturally defined as favorite localities that were used continuously for a long time span.

The burial facilities were shallow rectangular pits in the ground, with a few oval exceptions. They were small and not much larger than the bodies they contained. The pits primarily aligned along an east–west axis with the heads of the skeletons pointing toward the west. The mean pit orientation is 267.5° with a standard deviation of 10.4°. Distribution of the grave orientations shows a more-or-less normal (or slightly left-skewed) distribution with three outliers exceeding 310° (Fig. 9). None of the burial pits showed trace of a casket. This stage of the burial rite was quite uniform, small earthen pits orienting toward the west were dug to contain the bodies.

The next stage—treatment of the body—varied highly. First, the funeral directors had to decide on the number of interments to be inhumed in the burial pit. Most of the burials contained only one interment; nevertheless, 48 graves contained multiple interments of up to 6 individuals of mixed sexes and different ages (Table 3). Most of the collective burials comprised secondary interments, indicating a funeral program of several stages. Eleven graves are classified as exhumed burials, that is, most of the skeletal elements had been removed from the graves. These burials might be asymmetrical mirrors of the secondary burials; however, the huge disparity between the secondary interments and exhumed graves (156 vs. 11) indicates that there was hardly a one-to-one correlation.

There were several choices for body posture. Most of the primary burials were placed in an extended supine posture, with a few in an extended prone position. For the secondary burials, most of the elements were collected and placed in bundles, with four exceptions where the elements were rearticulated according to human anatomy. In addition, it is apparent that the Jiahu people practiced a ritual of body severance that involved the removal of the head or the limbs during the funeral. Thirty-seven primary interments were missing osteological elements of the skull, mandible, humerus, radius, ulna, femur, tibia, fibula, or other smaller elements of the extremities. The articulation of the remaining elements suggests that they are different from the exhumed burials and the rearticulated secondary burials discussed above. The skulls or limbs were intentionally severed postmortem, leaving the remaining skeleton intact. Hereafter we refer to them as "element-removed burials." There is indication that the removed elements might have circulated in the living community of Jiahu (see below).

Lastly, the funeral directors had to decide on the number and types of burial goods. Eighty-four (24.1%) of the graves lack offerings; they were unfurnished or furnished only with perishable artifacts. The majority of the graves yielded some remains of offerings. The number of offerings was usually small but highly varied; the mean is 3.60 and the standard deviation almost doubles at 6.62. The highly skewed distribution shows most graves were furnished with few offerings but a

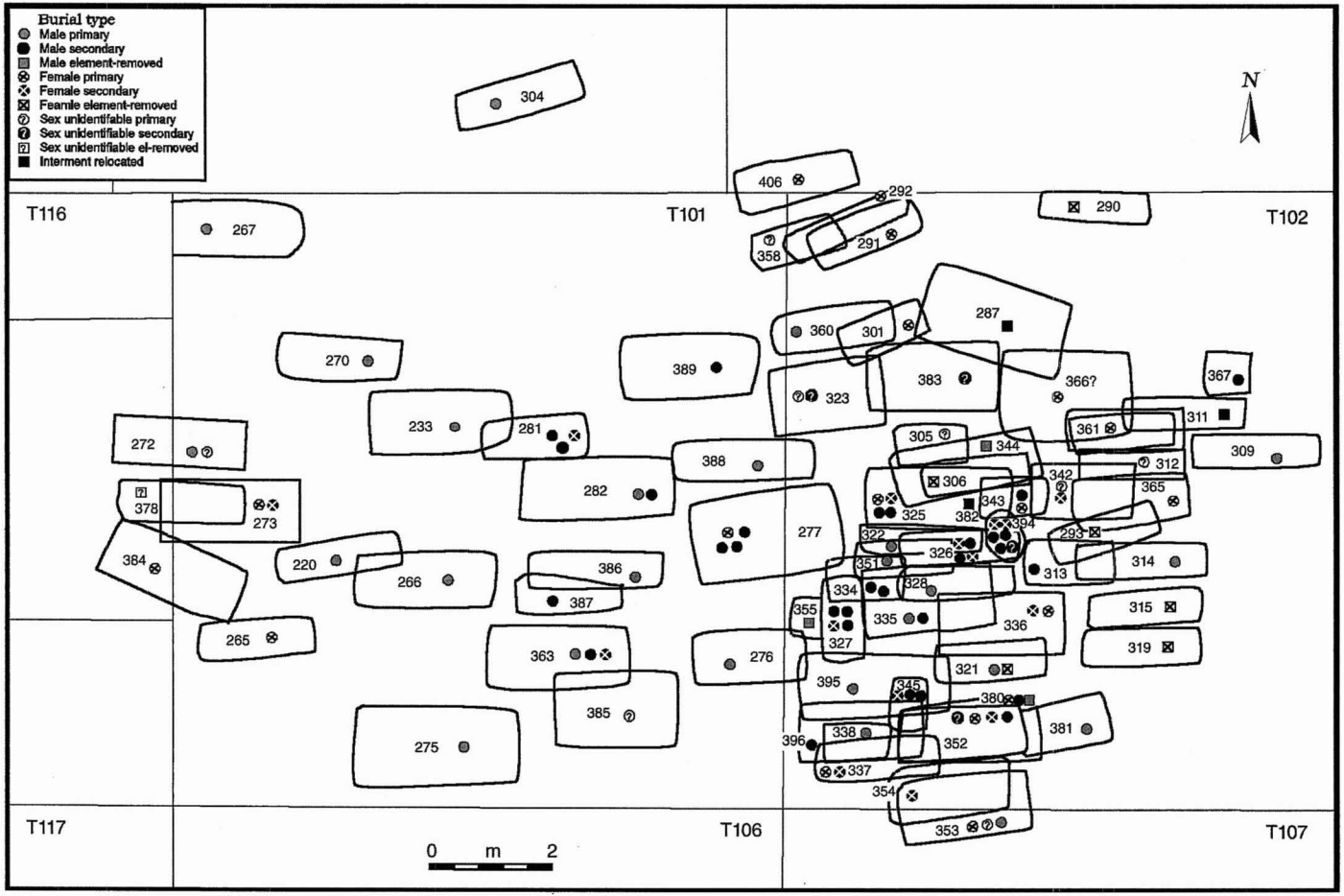


Fig. 7. Distribution of graves in disposal area Ea, phase II, Jiahu.

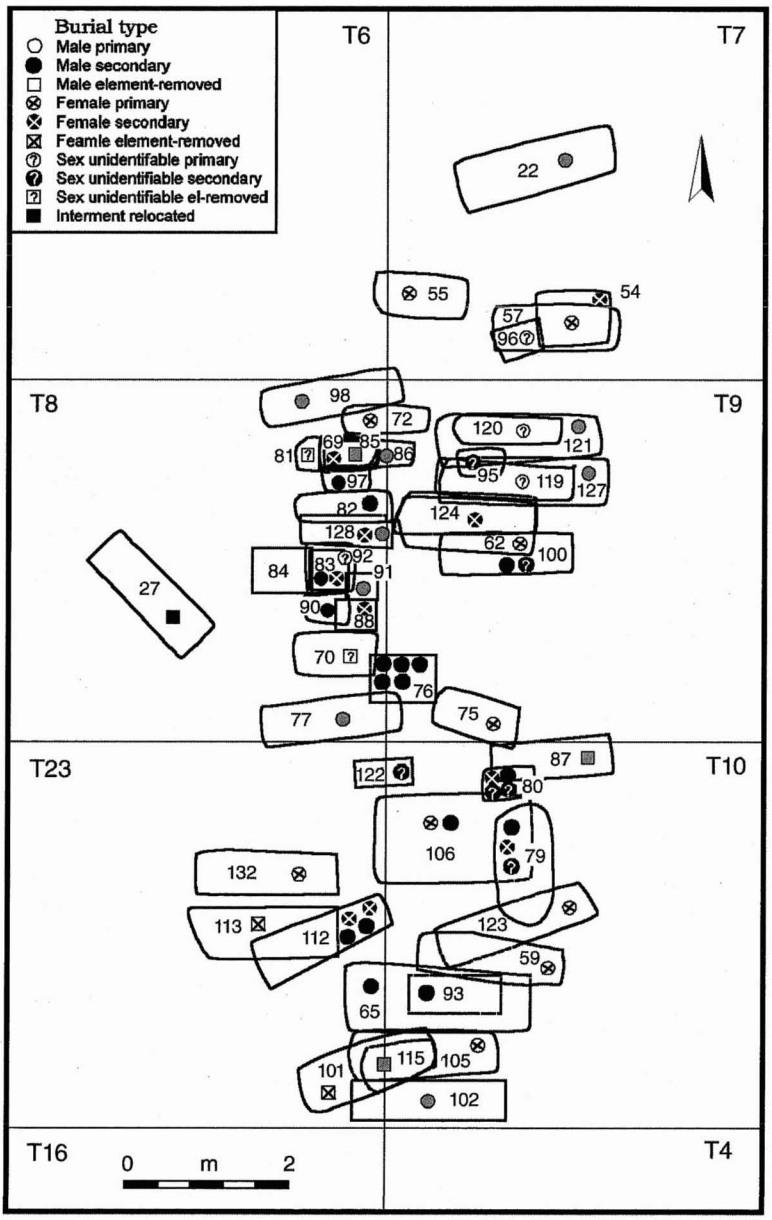


Fig. 8. Distribution of graves in disposal area Eb, phase II, Jiahu.

few graves were furnished with outstanding material wealth (Fig. 10). The richest single-interment burial was M282, the grave of a 35-year-old male, which yielded 60 artifacts. Most of the burial goods were utilitarian tools, such as domestic pottery vessels (*hu* [vase], *guan,* and *ding*), possibly stone farming tools (axe), stone working tools (chisel and quern), hunting and fishing tools (arrowhead and harpoon), bone domestic tools (awl, knife, cutter, and needle), and

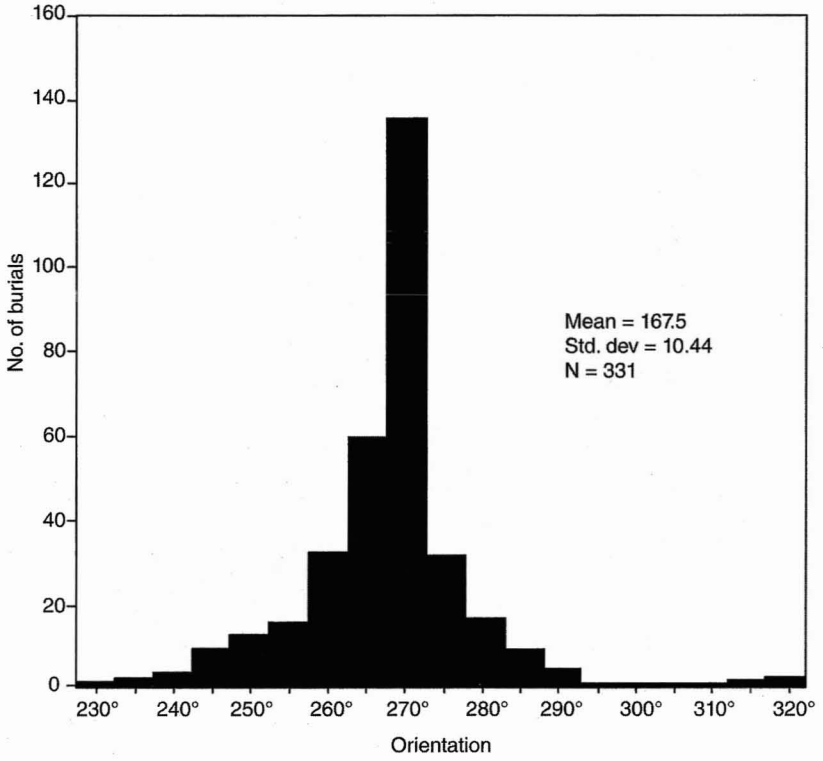


Fig. 9. Distribution of the orientations of Jiahu earthen graves.

bone and antler materials not yet cut to form. Furthermore, this individual was also offered with two bone flutes, two turtle shells, and apparel adornments made of bone and animal tooth. Most intriguing of all is the finding of a right mandible of a male of about 45 years old on the chest of the primary interment. This element might have been circulated in the living community before being buried.

Most of the offerings to the dead were artifacts used in daily life. Use-wear is obvious on some of the utilitarian tools, indicating that they had actually been

TABLE 3. SUMMARY OF BURIAL TYPES, JIAHU

| PHASE | I | II | III | TOTAL |
|---|---|---|---|---|
| Single burial | 41 | 134 | 123 | 298 |
| Multiple burial | 1 | 33 | 14 | 48 |
| Primary extended supine | 29 | 101 | 94 | 224 |
| Primary extended prone | 6 | 3 | 1 | 10 |
| Secondary bundle | 21 | 81 | 50 | 152 |
| Secondary articulated | 1 | 3 | 0 | 4 |
| Limb missing | 5 | 12 | 11 | 28 |
| Head missing | 0 | 8 | 5 | 13 |
| Exhumed | 1 | 7 | 3 | 11 |

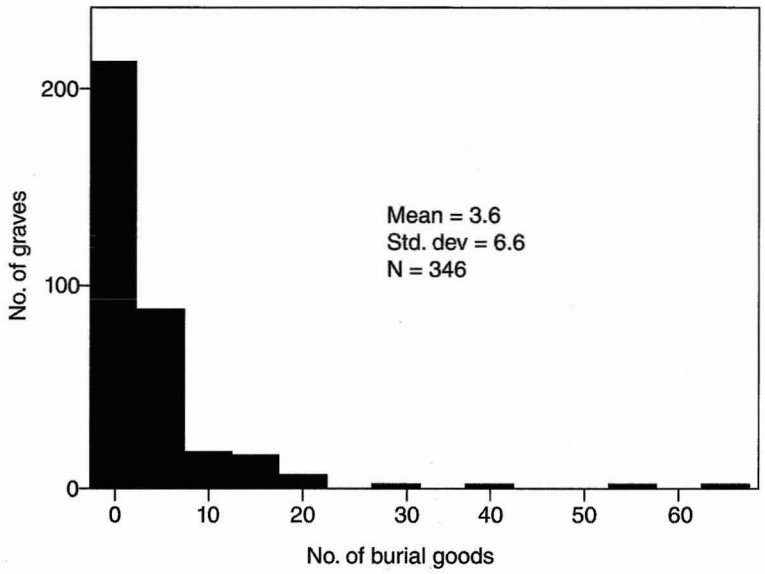


Fig. 10. Distribution of burial goods by grave.

used. There were also apparel adornments, such as bracelets, pendants, and beads made of stone and bone; they were likely coincidental to the death events. Their location in relation to the body suggests that at least some were worn by the individuals at the time of their death, rather than intentionally offered during the funeral rite (O'Shea 1984:24). In addition, unworked material of bone, antler, tooth, and shell, and bone cut into board were also uncovered from the burials.

Several burials yielded animal bones, often mandibles of pig, cattle, and dog. It is not clear whether they were offered as provisions to the dead with meat intact, or whether the bone with no meat was offered, which would have likely served as a memento. There are questions concerning the offerings contained in the pottery vessels. Were the vessels themselves viewed by the Jiahu people as offerings? Or, were the materials held in the vessels the actual offerings?

*Hu* vessels are the most popular burial goods in Jiahu, with a globular body, two small ears on the shoulder, a neck, and a small, unrestricted mouth (Fig. 11). They are particularly suited for preparing, storing, and serving beverages. Archaeologists have long speculated that *hu* were used to hold alcoholic beverages. In a recent residue study, sherds from 16 vessels from Jiahu were analyzed by a number of different chemical techniques, and 13 of them yielded results. The residues extracted from these vessels suggest that they are chemically most similar to one another, and include traces from rice, honey, and grape or hawthorn fruit (McGovern et al. 2004). Direct chemical evidence of alcohol is lacking because this compound is volatile and susceptible to microbial attack. In any event, the finding supports the hypothesis that the *hu* were used for a mixed fermented beverage. It is very likely that alcohol was served to the dead during the inhuming ceremony.

Although all of the above burial goods probably had specific symbolic meanings in the Jiahu community, some burial goods seem unique when viewed in

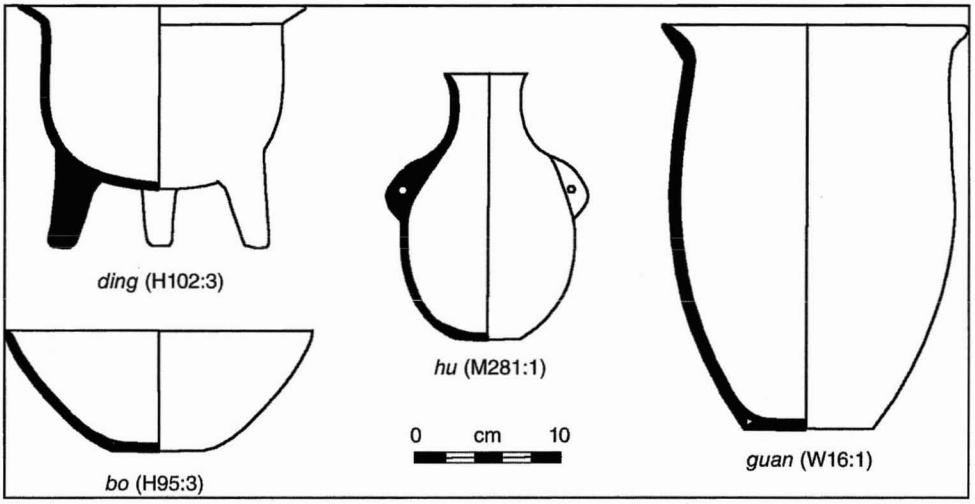


Fig. 11. Examples of vessel classes of Jiahu (redrawn after Henansheng 1999:222, 240, 279, 307).

the mortuary context alone. They include flutes, two-pronged bone implements (Fig. 5), turtle shells containing pebbles of different colors, and animal mandibles. The function and meaning of these unusual symbols have invited much speculation but no agreement. Albeit their exact function and meaning are debatable, archaeologists all agree that they were artifacts used in the social and ideological realms of the Jiahu culture system. As we will demonstrate later, the differential distribution of these burial goods suggests special social status of the deceased. Therefore, we collectively subsume them under the category of prestigious symbols.

## QUANTITATIVE VARIATION OF BURIAL GOODS

The above section not only summarizes the various decisions the funeral directors had to make about the treatment of the dead, it also isolates several potentially important elements in the mortuary program of Jiahu. In the following, we further examine the quantitative differentiation of burial goods with cluster analysis, without considering the factors of sex, age, and spatial separation. The major goal of this quantitative study is to discern the underlying social factors that may explain these differences in burial goods. Our strategy ensures that the clustering results are not influenced by our previous knowledge of the social factors. The clustering classifications of the graves are based only on the quantitative variation of burial goods. These independent results are then correlated with the other patterned traits identified above. In addition, we aim to investigate the possibility of diachronic change. Cluster analysis is therefore conducted on the three temporal phases as suggested by the stratigraphy. Finally, these various schemes of grouping of the graves are evaluated by the pathological pattern of the human remains of the same graves.

All quantitative methods involve the transformation of observations into numbers. The transformation for the present study is straightforward in that the raw

counts of burial goods are used for the quantitative study. Thus, the observation of one milling stone in a grave is coded as one under the variable of grain-processing tool and the observation of one bone needle is coded as one under the variable of bone needle. Consequently, they weigh equally in our quantitative study. It is abundantly clear to all archaeologists that milling stones and bone needles weigh differently, both physically and culturally. When observations are reduced to numerals, it is easy to lose sight of the cultural context. Therefore, it is essential for us to critically assess the quantitative results from a cultural perspective, particularly from the context of the past culture in question. Our goal is not to identify the quantitative patterning per se, but to decipher the social and cultural implications of the quantitative patterning. We need to think carefully about how to treat the variables before subjecting them to abstract statistical procedures.

### *Variable Treatment*

The burial goods of Jiahu are partitioned into about 50 classes of artifacts and ecofacts in *Wuyang Jiahu*, the two-volume technical report. Some artifact and ecofact classes, particularly the former, have very low frequencies. Coupled with the fact that the Jiahu burials in general yielded a small number of burial goods, using all the artifact classes as variables in cluster analysis would produce many small clusters that have trivial meanings and mask the bigger picture of the society. To avoid this happening, it is necessary to collapse some artifact classes into more inclusive groups.

How to join the artifact classes is a question that must be considered within the quantitative patterning and the context of Jiahu mortuary practice. Here we use the frequency, distribution pattern, and Pearson's product moment correlation coefficients to monitor the quantitative patterning. From a statistical point of view, to use several highly correlated variables in a multivariate procedure is to weigh the underlying factors that they represent heavier than necessary. Highly correlated variables should be either combined in some way or only one variable be used. However, this procedure must be evaluated in the frequencies and distribution patterns of the artifact classes, and the underlying sociocultural processes that regulated the offering of burial goods in the first place.

Phase II burials are ideal to illustrate our procedures because they yielded the highest variation of burial goods and the largest number of cases, thus producing the strongest pattern in the correlation matrix. Table 4 is the correlation matrix of 23 artifact classes. Some artifact classes of very low frequency have already been collapsed according to their assumed functions. For instance, the 20 axes and spades are joined to form one single artifact class, stone farming tool, based on the assumption that stone axes were used for field clearing and spades for tillage. Single occurrence burial goods, such as pigment, which was present in only one burial, have been excluded from the matrix. Also excluded from the derivation of the correlation table are the 25 unfurnished graves; including these empty graves would have a skewing effect on the correlation coefficients. As a result, a total of 142 phase II graves are used in the compilation of the coefficient matrix.

The correlation matrix organizes the artifact classes into five groups according to the material and assumed functions. They are pottery vessels, stone tools, apparel adornments (made of stone and bone), bone tools, and prestigious symbols.

TABLE 4. CORRELATION MATRIX OF ARTIFACT CLASSES, PHASE II, JIAHU

| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.** *hu* | .017 | −.100 | .029 | .018 | .101 | −.021 | −.003 | −.003 | −.007 | .005 | .011 | .210 | .033 | .074 | .094 | .038 | .132 | .035 | −.009 | .108 | −.005 | .088 | **1** |
| **2.** *guan* | | .058 | .081 | .121 | .182 | .272 | −.034 | −.034 | .037 | −.012 | −.014 | .026 | .020 | .116 | −.014 | −.038 | −.071 | .069 | .054 | .194 | .110 | .204 | **2** |
| **3.** *ding* | | | .004 | .140 | −.045 | .290 | −.019 | −.019 | −.049 | .072 | .133 | .053 | .194 | .086 | .171 | .162 | −.020 | .257 | .101 | −.049 | −.037 | −.018 | **3** |
| **4.** *bo* | | | | −.075 | .003 | .052 | −.021 | .768* | .200 | .068 | .168 | .104 | −.004 | −.050 | .045 | −.002 | .045 | .021 | .065 | −.004 | −.021 | .119 | **4** |
| **5.** stone farming tool | | | | | .123 | .380 | −.025 | −.025 | .051 | .356 | .008 | .076 | .203 | .183 | .232 | .282 | −.044 | .230 | .181 | .311 | .021 | .113 | **5** |
| **6.** stone processing tool | | | | | | .101 | −.017 | −.017 | −.043 | .004 | .031 | .047 | .081 | −.040 | −.028 | −.073 | −.036 | .045 | −.052 | −.043 | .011 | −.052 | **6** |
| **7.** stone working tool | | | | | | | −.022 | .129 | .138 | .032 | .269 | .199 | .366 | .306 | .204 | .381 | −.007 | .555* | .367 | .138 | −.043 | .228 | **7** |
| **8.** stone scraper | | | | | | | | −.007 | .306 | −.024 | −.023 | −.013 | −.022 | −.017 | −.003 | .085 | −.019 | .044 | −.022 | −.018 | −.014 | −.022 | **8** |
| **9.** stone spindle whorl | | | | | | | | | .306 | .153 | .229 | −.013 | −.022 | −.017 | −.034 | −.031 | −.019 | .000 | −.022 | −.018 | −.014 | −.022 | **9** |
| **10.** other stone tools | | | | | | | | | | −.004 | .022 | −.033 | −.057 | .067 | −.077 | −.043 | −.032 | .000 | −.057 | .215 | −.035 | −.039 | **10** |
| **11.** stone adornment | | | | | | | | | | | .056 | −.042 | −.028 | .242 | .244 | .180 | .179 | .054 | .036 | −.004 | −.023 | −.026 | **11** |
| **12.** bone adornment | | | | | | | | | | | | .072 | .357 | .116 | .068 | .247 | −.028 | .267 | .240 | .022 | −.045 | .170 | **12** |
| **13.** bone unworked material | | | | | | | | | | | | | .524* | .047 | .577* | .387 | .492* | .381 | .054 | .077 | .093 | .177 | **13** |
| **14.** bone board | | | | | | | | | | | | | | .170 | .398 | .342 | .203 | .512* | .257 | −.057 | .008 | −.013 | **14** |
| **15.** antler, shell, tooth | | | | | | | | | | | | | | | .066 | .201 | .065 | .406* | .089 | .287 | −.033 | .021 | **15** |
| **16.** arrowhead | | | | | | | | | | | | | | | | .638* | .369 | .380 | .156 | .013 | .050 | .052 | **16** |
| **17.** harpoon | | | | | | | | | | | | | | | | | .241 | .541* | .393 | .135 | −.015 | .168 | **17** |
| **18.** bone needle | | | | | | | | | | | | | | | | | | .304 | −.003 | −.032 | .079 | −.033 | **18** |
| **19.** bone domestic tool | | | | | | | | | | | | | | | | | | | .339 | −.043 | .029 | .096 | **19** |
| **20.** bone flute | | | | | | | | | | | | | | | | | | | | .111 | −.042 | .405* | **20** |
| **21.** bone 2-pronged implement | | | | | | | | | | | | | | | | | | | | | .258 | .477* | **21** |
| **22.** mandible | | | | | | | | | | | | | | | | | | | | | | .358 | **22** |
| **23.** turtle shell | | | | | | | | | | | | | | | | | | | | | | 1.00 | **23** |

Pottery vessels

Stone tools

Adornments

Bone artifacts

Prestigious symbols

*$r > .4$

The within-group correlation illustrates that the groups of pottery vessels, stone tools, and apparel adornments have very low coefficients, suggesting that there exist no or very weak relationships among the artifact classes within the same group. For instance, the correlations of the four pottery vessel classes, *hu*, *guan*, *ding*, and *bo*, range between 0.081 and 0.100 (Fig. 11). Based on the correlation coefficient alone, each of these 12 artifact classes should be treated as a single variable in the cluster analysis. However, closer investigation into their frequency and distribution, and experiments with cluster analysis suggest that it is undesirable to treat each of them as a single variable. Let us first look at the pottery vessels.

*Hu* was the most popular burial good in Jiahu. One hundred and forty-seven *hu* were found in 103 (out of 167) phase II graves. Most of these *hu*-bearing graves yielded one to two *hu*, with 11 exceptions that yielded three to eight. However, all these 11 graves were collective burials containing two to six interments. When the number of interments is taken into consideration, *hu* is to a certain extent evenly distributed among the phase II graves, as well as graves of other phases. Many individuals were offered with *hu*, and nobody had more than a few.

The other three vessel classes, *guan*, *ding*, and *bo*, all have low frequencies and usually occurred singularly. Twenty-five *guan* were found in 22 graves; 7 *ding* were found in 7 graves; and finally 19 *bo* were found in 13 graves. The correlation coefficient matrix has already demonstrated that the distribution of the *hu*, *guan*, *ding*, and *bo* are independent of each other. In fact, only 26 out of the 113 phase II vessel-bearing graves (23%) yielded more than one vessel class.

Given the above quantitative attributes of the pottery vessels, experiments of cluster analysis using the four vessel classes as independent variables generated a large cluster of *hu*-bearing graves and several small clusters, each defined by one of the other three vessel classes. As argued above, in the context of the Jiahu funeral rite, what was important was not the vessels per se, but the provision contained in the vessels. Although the morphologies of the vessels suggest that each might have contained different kinds of provision, their presence indicates the ritual aspect of provisions offered to the dead. Furthermore, treating all the vessel classes as one variable produced cluster solutions with clarity that suit our stated goal. In the following, only the solutions of the cluster analysis collapsing the four vessel classes into one variable will be presented in detail and an experiment treating the four pottery vessel classes as independent variables will be briefly discussed.

The frequency and distribution pattern of each of the artifact classes of the groups of stone tools and apparel adornments are similar to those of *guan*, *ding*, and *bo*, that is, low overall frequency and no grave yielded a significant amount of any of the artifact classes. Twenty stone farming tools were found in 14 phase II graves; 7 stone processing tools were found in 6 graves; 21 stone working tools were found in 14 graves; 1 stone scraper was found in 1 grave; 2 stone spindle whorls were found in 1 grave; 8 other stone tools were found in 7 graves; 19 stone apparel adornments were found in 12 graves; and finally, 11 bone apparel adornments were found in 11 graves. The two classes of adornments show no relationship, whereas three indices in the stone tool group exceed 0.3 but are less than 0.4, at best a weak correlation. With the same reasons applicable to the pottery vessels, we are going to present the results of cluster analysis that treat these eight artifact classes as two larger artifact categories of stone tools and adornments.

Although the stone artifacts were used for widely different tasks, using them as independent variables in cluster analysis produces many small groups that are hard to interpret. For instance, the grave yielding the two spindle whorls would form a cluster by itself. It might mean that craft specialization was a consideration in the funeral ritual, but one isolated case does not constitute a pattern that can help us understand the social relations of Jiahu.

The artifact classes of these three groups also exhibit no correlation with other artifact classes across the board, except in two cases. The exceptions are the correlation between *bo* and spindle whorl, and between stone working and bone domestic tools. The correlation of the former, 0.768, is the strongest correlation in the entire matrix. The two spindle whorls were found in grave M342. This grave also happened to yield a high number of five *bo* vessels. After examining the co-distribution pattern of *bo* and spindle whorls, we maintain that this is a spurious correlation coefficient, and does not have much sociocultural implication. On the contrary, the higher frequency of stone working and bone domestic tools suggests that the coefficient of 0.555 is an "honest" representation of their correlation. However, these two classes of artifacts likely represent two different types of activities. We therefore decided to keep them as two separate variables in the cluster analysis that follows.

In contrast to the pottery vessels, stone tools, and apparel adornments, the within-group correlations of bone tools and prestigious symbols show some moderately positive correlations. The bone tools are partitioned into four different groups in the cluster analysis. Most of the bone tool classes have very weak correlations among themselves; however, there exist seven moderate to strong correlations ($>0.4$). Arrowheads and harpoons have the strongest correlation at 0.638, so they are collapsed into one group. In addition, their assumed hunting and fishing functions support the union. We then treat all the unworked and unfinished bone, antler, and shell materials as a group. Although there is only one significant paired relationship between unworked bone material and bone board (0.524), these three artifact classes are combined because they all share the characteristic of being unfinished products. The remaining two artifact classes comprised of bone, needle, and domestic tools do not have significant correlation between them. They are treated as two different variables in the cluster analysis.

For the group of symbols, there exist two moderately significant paired correlations between turtle shell and bone flute (0.405), and between turtle shell and two-pronged implement (0.477). These are not particularly strong positive correlations. The correlation of flute and two-pronged implement, however, is a mere 0.111. We suspect that each of these symbolic artifacts might have unique meaning in the Jiahu community. Therefore, all the symbolic artifacts are treated as individual artifact classes in the cluster analysis.

As a result, the cluster analyses used the following 11 artifact groups as variables: pottery vessels, stone tools, adornments, hunting/fishing tools, bone material, bone needles, bone domestic tools, bone flutes, two-pronged bone implements, animal mandibles, and turtle shells. Because of the absence of bone material from phase I burials, its cluster analysis used only ten variables.

As discussed above, one milling stone is not the equivalent of one bone needle. This difference would be exaggerated if the raw counts of artifacts were used in cluster analysis. Variables with high variances would overwhelm the clustering

results. One way to eliminate this effect is to standardize the variables. We standardized the raw counts into z-scores. A z-score is an index that measures the number of standard deviation units by which the value in question departed from the mean of the variable. In this way, the value of a variable of a case is evaluated within the variance of the respective variable. This procedure produces cluster solutions that weigh heavier on variables that have highly differentiated distribution among the cases. Variables that are evenly distributed play lesser roles in the clustering. This effect suits our study well because we are more interested in the differential mortuary treatment among the graves.

### *Cluster Analysis*

Cluster analysis is a family of multivariate statistical procedures that generate classifications. It sorts objects into groups in a way that maximizes the similarities of the members of the same groups and minimizes that between the members of different groups. In the present study, similarities are measured in the z-scores of the frequencies of the 11 variables of burial goods. Grouped graves are not necessarily identical and could show variation among themselves. Nonetheless, they share at least one unique characteristic that is not shared with other groups.

We use the hierarchical agglomerative method that treats each of the cases as a group in the beginning and systematically joins the cases to form larger groups until all the cases are joined into one single group. The key to the agglomeration procedure is to determine when to stop the joining, or the number of clusters. Statisticians suggest the use of different examinations of the fusion coefficients to look for a sudden change or jump (Aldenderfer and Blashfield 1984:54–57).

The cluster analysis was conducted by SPSS (Statistical Package for the Social Sciences) version 9.0. There are choices in similarity measurement and linkage method in SPSS. We chose the squared Euclidean distance, which is appropriate for the similarity measure of interval scale variables. For the linkage method, we chose the Ward's method, which has the ability to optimize the minimum variance within clusters and maximizes the within-cluster homogeneity (Aldenderfer and Blashfield 1984:43).

*Phase I* — The optimal solution for the 42 phase I graves is the seven-cluster solution. Cluster analysis is a structure-imposing technique. Not only is finding a classification important to our study, also important is to test whether the classification based on the variation of burial goods has sociocultural implications. Some of the sociocultural aspects, such as sex and lineage, implicate a more-or-less equal partitioning of the sample. The fusion coefficients suggest multiple cutoff points of the joining procedure. The cluster solutions of lesser clusters partition the sample into one large group and several unique but small groups that were furnished with symbolic artifacts. The seven-cluster solution partitions the sample into two larger groups of more or less equal size (clusters 1 and 2) and five small groups (Table 5).

Overall, offerings to the phase I burials are meager (mean = 4.00), and the distribution varies (standard deviation = 4.08). Given our research interest, we organized the clusters into a vertical order: the graves that are furnished with excep-

TABLE 5. MEANS AND STANDARD DEVIATIONS OF ARTIFACT CLASSES BY CLUSTER, PHASE I, JIAHU

| VERTICAL ORDER | COMMON | | PRESTIGIOUS | | | | |
|---|---|---|---|---|---|---|---|
| Cluster | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| No. burials | 21 | 15 | 1 | 1 | 1 | 2 | 1 |
| Pottery vessels | 1.10[a] | .07 | 1.00 | 1.00 | 0 | .50 | 1.00 |
| | .30[b] | .26 | — | — | — | .71 | — |
| Stone tools | .05 | .00 | 0 | 0 | 0 | 1.00 | 1.00 |
| | .22 | .00 | — | — | — | 1.41 | — |
| Adornment | .29 | .13 | 0 | 1.00 | 0 | 7.50 | 0 |
| | .78 | .35 | — | — | — | 3.54 | — |
| Hunting/fishing tools | .10 | 1.40 | 0 | 4.00 | 1.00 | 2.50 | 1.00 |
| | .44 | 2.06 | — | — | — | 3.54 | — |
| Bone needle | .29 | .53 | 0 | 9.00 | 0 | 1.50 | 0 |
| | .46 | .64 | — | — | — | .71 | — |
| Domestic tools | .95 | .47 | 2.00 | 4.00 | 1.00 | 1.00 | 0 |
| | .74 | .64 | — | — | — | .00 | — |
| Bone flute | .00 | .00 | 0 | 0 | 2.00 | 0 | 0 |
| | .00 | .00 | — | — | — | — | — |
| 2-pronged implement | .00 | .00 | 2.00 | 0 | 0 | 0 | 1.00 |
| | .00 | .00 | — | — | — | — | — |
| Animal mandible | .00 | .07 | 0 | 0 | 1.00 | 0 | 0 |
| | .00 | .26 | — | — | — | — | — |
| Turtle shell | .00 | .00 | 0 | 0 | 1.00 | 0 | 8.00 |
| | .00 | .00 | — | — | — | — | — |
| Total | 2.76 | 2.67 | 5.00 | 19.00 | 6.00 | 14.00 | 12.00 |
| | 1.26 | 2.61 | — | — | — | 1.41 | — |

[a] mean [b] standard deviation

tional material wealth (clusters 3–7), and the graves that are poorly furnished (clusters 1 and 2). In each of the vertical levels, burials are grouped into smaller clusters and each of the clusters is defined by unique occurrences of particular artifact classes. This partition represents the horizontal differentiation within the higher and the lower levels.

The homogeneity and the defining features of the clusters can be evaluated from their means and standard deviations. The fact that within each cluster, the standard deviations of many of the artifact classes are greater than the means indicates that great variance exists among the graves of the same clusters. However, when we look at the pottery vessels of cluster 1, the mean is 1.10, while the standard deviation is quite small at 0.30. Closer examination of cluster 1 indicates that all 21 graves yielded at least one pottery vessel, with two instances yielding two. Therefore, the diagnostic characteristics of cluster 1 are that the graves were poorly furnished, but they yielded at least one vessel.

Similar to cluster 1, cluster 2 also comprises poorly furnished graves; however, they did not yield any pottery vessels. The only exception is M109, which yielded a *hu* vessel, but also two bone harpoons, one bone arrowhead, and one bovid mandible. The clustering schedule indicates that in the previous step of clustering, this case is a cluster by itself. In summary, cluster 1 and cluster 2 are

graves that are furnished with few offerings with a highly heterogeneous distribution of most of the artifact classes, separated from each other based on the presence or absence of pottery vessels.

The six richly furnished graves are highly varied in that they are classified into five small clusters, wherein four clusters have only one member grave and one cluster has two member graves. They are defined by the occurrence of two-pronged implements (cluster 3), bone flute (cluster 5), a large number of apparel adornments (cluster 6), a large number of turtle shells (cluster 7), and a large number of bone tools (cluster 4). These burials, in general, yielded more burial goods than the burials of clusters 1 and 2.

The clustering results of phase I not only produce a classification scheme for us to test against the treatment patterns, they also confirm our intuition that bone flutes, two-pronged implements, animal mandibles, and turtle shells were special symbols in the Jiahu community. They are identified by the cluster analysis as defining elements in the classification schedule of the richly furnished graves. Graves yielding these four classes of artifacts were also richly furnished with other grave offerings. Based on the previous discussion on the mortuary program of Jiahu, it is reasonable to interpret these richly furnished graves as the "prestigious" graves and the other graves as the "common" burials. This interpretation will be later evaluated in the other patterns of variation, particularly that of pathology.

When each of the pottery vessel classes is treated as an independent variable, the clustering result conflicts with our previous understanding of the sociocultural meanings of some of the highly symbolic artifacts. The pottery vessel assemblage of phase I comprises only *hu* and *guan*; therefore the pottery assemblage is attributed to two variables. In fact, only two *guan* were yielded from two different graves among the 42 phase I graves. The experiment joined the two *guan*-yielding graves in an early stage; M374 had three grave offerings, one each of *hu*, *guan*, and bone cutter, whereas M125 had 12 grave offerings, one each of *guan*, arrowhead, stone-processing tool, and two-pronged implement, and eight turtle shells. The shared characteristic of one *guan* in the two graves overwhelmed their considerable difference in symbolic artifacts. This result contradicts our intuition that the two-pronged implement and turtle shell had special meaning in the Jiahu community. This experiment justifies collapsing the pottery vessel classes into one variable in the cluster analysis.

*Phase II* — Phase II as a whole yields the most richly furnished graves among the three phases. It has the largest number of cases ($n = 167$), the highest total number of burial goods (mean = 5.42), and the greatest between-grave variation (standard deviation = 8.61). The optimal solution is the eight-cluster solution, which is determined with the same heuristic strategy described above. Table 6 gives the means and standard deviations of the artifact classes by cluster. In a dichotomy of "prestigious" versus "common" graves, clusters 3 to 8 comprise the higher echelon while clusters 1 and 2 are those of the lower echelon.

The prestigious clusters score high in sheer number of burial goods in that their means are at least one standard deviation above that of the entire phase II burials. Yet, each of the prestigious clusters has its own characteristics. Cluster 3 is defined by apparel adornments; all ten burials yield at least one bone or stone adornment. Clusters 4 and 5 are quite similar; both yield a large number of arrowheads and

TABLE 6. MEANS AND STANDARD DEVIATIONS OF ARTIFACT CLASSES BY CLUSTER, PHASE II, JIAHU

| VERTICAL ORDER | COMMON | | | PRESTIGIOUS | | | | |
|---|---|---|---|---|---|---|---|---|
| Cluster | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| No. burials | 108 | 39 | 10 | 2 | 1 | 5 | 1 | 1 |
| Pottery vessels | .55[a] | 2.51 | 1.40 | 3.00 | 3 | 2.60 | 3 | 2 |
| | .54[b] | 1.62 | .84 | 1.41 | — | 1.14 | — | — |
| Stone tools | .23 | .28 | .80 | 0 | 7 | .80 | 4 | 0 |
| | .72 | .79 | .92 | — | — | .84 | — | — |
| Adornment | .06 | .08 | 1.90 | .50 | 1 | .40 | 0 | 0 |
| | .23 | .35 | .74 | .71 | — | .89 | — | — |
| Bone material | .04 | .15 | 1.30 | 3.50 | 6 | .40 | 1 | 0 |
| | .19 | .43 | 1.64 | 4.95 | — | .55 | — | — |
| Hunting/fishing tools | .30 | 2.51 | 3.70 | 15.00 | 17 | 3.20 | 0 | 1 |
| | .69 | 4.34 | 3.74 | 16.97 | — | 4.97 | — | — |
| Bone needle | .25 | .28 | .80 | 5.00 | 2 | .20 | 0 | 1 |
| | .99 | .60 | 1.32 | 5.66 | — | .45 | — | — |
| Domestic tools | .53 | .82 | 1.80 | 5.00 | 17 | 1.40 | 0 | 1 |
| | .95 | 1.19 | 2.04 | 2.83 | — | 2.07 | — | — |
| Bone flute | .01 | .15 | .10 | 0 | 2 | 1.00 | 0 | 0 |
| | .10 | .49 | .32 | — | — | 1.00 | — | — |
| 2-pronged implement | .01 | .08 | 0 | 0 | 0 | 1.00 | 5 | 2 |
| | .10 | .27 | — | — | — | .71 | — | — |
| Animal mandible | .06 | .03 | .00 | .00 | 0 | 0 | 0 | 7 |
| | .30 | .16 | — | — | — | — | — | — |
| Turtle shell | .04 | .08 | .20 | .50 | 2 | 7.60 | 1 | 8 |
| | .19 | .48 | .63 | .71 | — | .89 | — | — |
| Total | 2.06 | 6.97 | 12.00 | 52.50 | 57 | 18.60 | 14 | 22 |
| | 2.20 | 4.65 | 5.27 | 20.51 | — | 7.54 | — | — |

[a] mean [b] standard deviation

harpoons, yet they are different in the frequencies of bone needles and domestic tools. Clusters 6, 7, and 8 are the most outstanding clusters because they all have prestigious symbols of turtle shell and animal mandible.

Clusters 1 and 2 are similar because they are the "poor" graves. Their mean totals are much smaller than the prestigious graves. However, the common burials of clusters 1 and 2 were not entirely poor. Although most of these burials had few burial goods, some of them yielded a considerable number of offerings that matched the quantities of the prestigious graves. In addition, they also yielded a few prestigious objects that included seven bone flutes, four two-pronged implements, five mandibles, and seven turtle shells from 13 graves. These graves had either few prestigious artifacts or a small total number of burial goods, which prevented them from being clustered with the prestigious group.

What separates clusters 1 and 2 is the number of pottery vessels. Most members of cluster 2 bear more than one vessel, whereas members of cluster 1 have no or only one vessel. The one-vessel burials of cluster 2 are M87, M90, M127, M270, M291, M388, M393, M395, and M402. A closer examination of these graves indicates that these one-vessel burials yielded unusually large number of arrowheads and harpoons, or yielded one to two bone flutes.

The clustering of graves was based on the quantity of offerings. However, 32 out of the 167 phase II graves were collective burials containing two to six interments, and seven of them have been classified as prestigious graves. We need to examine these seven graves to determine if the unusual treatment they received was a function of the number of interments. Although we can determine to whom some of the burial goods were offered from their placement in relation to the skeletons, more often than not we cannot determine this. It leaves us with one strategy: to divide the grave offerings evenly among the interments. As a result, three of these graves still have unusual quantities of grave offerings per interment.

For instance, M277, a member of cluster 4, was a collective grave containing the remains of four individuals. It yielded 66 counts of offerings; so, each individual was offered an average of 16.5, still unusual among the phase II burials. Among the assemblage of offerings, there are 21 arrowheads and harpoons, 21 bone needles, and a slide of mica, which likely originated from an exotic source. Grave M277, therefore, contained at least one individual who was unusually treated. Similarly, M335 and M353, yielding 9.5 and 12.7 counts of offerings per interment, respectively, are still regarded as unusually treated.

On the other hand, the number of offerings of M327 and M363, both members of cluster 6, dwindle to 3.2 and 5 per interment, respectively. Nevertheless, each of them yielded eight turtle shells. Based on the argument that turtle shells were a prestigious symbol in the Jiahu community, each of these two collective graves contained at least one prestigious individual.

Finally, M76 and M323 are no longer regarded as unusually treated after the number of interments is factored in. Not only do they yield low averages of 1.8 and 2.5 counts of offerings per interment, they also do not yield any prestigious symbols. They are no longer regarded as prestigious graves.

In all, the factor of collective graves does not considerably change the bigger clustering picture. The quantity and composition of at least 18 of the phase II graves are significantly different to those of the other graves.

This phase of burials shows some obvious quantitative difference in burial goods; however, the differences between the prestigious and common graves are more like a continuum rather than an abrupt distinction, and the access to prestigious goods does not seem to be exclusive.

*Phase III* — Phase III as a whole has the most deprived burials among the three temporal phases at Jiahu. The number and variance of burial goods significantly decreases (mean = 1.32, standard deviation = 2.45). Forty-three percent (59 out of 137) of the graves are unfurnished. Consequently, the differences between clusters are trivial.

We have determined that the eight-cluster solution is the optimal clustering solution (Table 7). Three single-member clusters—6, 7, and 8—clearly depart from the rest of the burials because they yield at least one of the prestigious artifacts of bone flute, two-pronged implement, animal mandible, and turtle shell. Cluster 5 is defined by the co-occurrence of stone tools and bone domestic tools, with a relatively high mean total of 10. A member grave of cluster 5 also yielded a bone flute. The above four clusters and five graves make up the higher order.

TABLE 7. MEANS AND STANDARD DEVIATIONS OF ARTIFACT CLASSES BY CLUSTER, PHASE III, JIAHU

| VERTICAL ORDER | COMMON | | | | PRESTIGIOUS | | | |
|---|---|---|---|---|---|---|---|---|
| Cluster | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| No. burials | 86 | 40 | 5 | 1 | 2 | 1 | 1 | 1 |
| Pottery vessels | .12[a] | 1.15 | 1.00 | 0 | 1.00 | 4 | 1 | 1 |
| | .32[b] | .36 | .71 | — | — | — | — | — |
| Stone tools | .24 | .03 | .80 | 1 | 2.00 | 0 | 0 | 0 |
| | .73 | .16 | 1.30 | — | 1.00 | — | — | — |
| Adornment | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | — | — | — | — | — | — | — | — |
| Bone material | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 1 |
| | — | — | — | — | — | — | — | — |
| Hunting/fishing tools | .06 | 0 | 0 | 0 | 1.50 | 6 | 3 | 0 |
| | .28 | — | — | — | 2.12 | — | — | — |
| Bone needle | 0 | 0 | 1.20 | 0 | 0 | 0 | 0 | 1 |
| | — | — | .45 | — | — | — | — | — |
| Domestic tools | .21 | .05 | 1.00 | 1 | 5.00 | 4 | 1 | 0 |
| | .56 | .22 | .00 | — | 1.41 | — | — | — |
| Bone flute | .01 | 0 | 0 | 0 | .50 | 1 | 2 | 0 |
| | .11 | — | — | — | .71 | — | — | — |
| 2-pronged implement | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | — | — | — | — | — | — | — | — |
| Animal mandible | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | — | — | — | — | — | — | — | — |
| Turtle shell | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 |
| | — | — | — | — | — | — | — | — |
| Total | .64 | 1.23 | 4.00 | 3 | 10.00 | 20 | 10 | 4 |
| | 1.24 | .53 | 1.22 | — | 2.83 | — | — | — |

[a] mean [b] standard deviation

The lower order can be subdivided into two larger subgroups and two smaller ones. Cluster 2 primarily comprises burials that yielded one, occasionally two, pottery vessels and no other artifacts. There are three exceptions to this, however. In addition to the pottery vessels, some of these burials also had either one stone tool or one bone domestic tool.

Cluster 1 is quite heterogeneous because it contains all the other poorly furnished graves. They include 59 graves that were unfurnished. It is worth mentioning that M99 contained a bone flute but was grouped with the other graves of cluster 1 because it was unfurnished. Lastly, cluster 3 is defined by the co-occurrence of bone needle and domestic tool, and cluster 4 is defined by the presence of personal adornment. Their total number of offerings and the trivial nature of the burial goods prompt us to argue that they are more appropriately grouped with cluster 1 of the lower order.

Fourteen of the phase III graves were collective burials with two to three interments. Two of them were classified by the cluster analysis as prestigious graves. The remaining collective graves were members of the lower order. Grave M263 of cluster 5 contained two interments and a total of 20 offerings, which

included one bone flute and one turtle shell. Grave 253 of cluster 7 also contained two interments. The ten offerings included two bone flutes, two turtle shells, and one two-pronged implement. Because of the presence of prestigious symbols, we argue that each of these two graves contained at least one individual of special status. The consideration of multiple interments does not change the clustering picture.

To summarize the results of the cluster analysis, the structures of the three temporal phases are very similar. The clustering procedures are successful in imposing the dichotomy of a hierarchical order of two levels, a small group of richly and specially furnished prestigious graves, and a large group of poorly furnished common graves.

The graves of the higher order are primarily defined by the co-occurrence of prestigious symbols and large numbers of other artifact classes, indicating the importance of symbolic artifacts in the wealth of grave offerings. Horizontally, the clustering procedures partition these graves into very small clusters because of the high variance of symbolic artifacts. Prestige might have emanated from different sources, and each of the sources was represented by one of the symbolic artifacts.

The graves of the lower order are those that yielded small numbers of burial goods, and usually no prestigious symbols. We are able to impose a structure that partitions these common burials into two smaller groups that each still comprise a considerable number of burials. The major difference between these two common clusters is the number of pottery vessels.

The various artifact classes show a differential significance in the clustering procedures. Symbolic artifacts are important in defining the vertical dimension of the burials. Hunting-fishing tools and apparel adornments are also significant in defining clusters of the higher order on several occasions. A small number of pottery vessels were recovered from most of the burials. They are important in the horizontal partitioning of the common burials. Needles and domestic tools, and other artifact classes are trivial because they play small roles in the clustering procedure.

Although the clustering structures remain unchanged throughout the three temporal phases of Jiahu, the wealth of grave offerings substantially increases from phase I to phase II, and then it reduces dramatically in phase III.

We need to reiterate that the difference between the prestigious and common graves does not show a clear line of demarcation, especially in phase II. Access to prestigious items was not monopolized by any specific group. Some symbol-yielding graves were not particularly rich in material wealth. This is an indication that the prestige system represented by the symbolic artifacts was not institutionalized (Carr 2006).

The most important question of cluster analysis is whether the classification is a "natural" classification. In our particular case, it is important to monitor how the classification of graves based on the variation of offerings interacts with the other aspects of the mortuary program.

### *Sex, Age, and Variation in Burial Goods*

Sex ratio bias against females is a common observation in Chinese Neolithic cemetery samples (Chen 1990; Gao and Lee 1993; Tang 1981; Wang 1980, 1999; Yang 1989; Zhang 1981:298–300). Given that the sex ratio at birth is only

TABLE 8. SEX RATIO OF IDENTIFIED INTERMENTS BY PHASES AND BURIAL TYPES, JIAHU

| SEX | PHASE I | PHASE II | PHASE III | TOTAL | SINGLE BURIALS | MULTIPLE BURIALS |
|---|---|---|---|---|---|---|
| Male | 27 | 117 | 78 | 222 | 153 | 69 |
| Female | 14 | 70 | 41 | 125 | 90 | 35 |
| Total | 41 | 187 | 119 | 347 | 243 | 104 |
| % male | 65.9 | 62.6 | 65.5 | 64.0 | 63.0 | 66.3 |
| *prob*[a] | .04 | .00 | .00 | .00 | .00 | .00 |

[a] Probability of binominal test based on 50.5% male at birth.

slightly biased against females cross-culturally, the bias of sex ratio in prehistoric cemetery samples must be attributed to cultural practices. In a census of contemporary societies compiled by the United Nations (1998; also see Dintelman et al. 1980), the sex ratio at birth worldwide is 102 males per 100 females. This ratio can be used to test the sex ratio observed in archaeology.

The Jiahu skeletal assemblage is heavily biased against females. Among the 347 interments identified as to sex, 222 (64%) are identified as male and 125 (36%) as female. This ratio is consistent through time. From phase I to phase III, the percentage of males is 65.9 percent, 62.6 percent, and 65.5 percent, respectively (Table 8). The largest difference (3.3%) is between that of phase I and phase II, but is still quite small. The observed sex ratios are then tested against the assumed percentage of 50.5 percent male at birth. All the differences between the observed percentages and assumed percentage are statistically significant (binomial test).

This biased sex ratio carries over to the difference between single and collective burials. In single burials, the percentage of male is 63.0 percent, and that for collective burials is 66.3 percent. Sex was not a factor in deciding whether to bury a body in a single grave or a collective grave.

In contrast, sex seems to be a significant factor in deciding burial good offerings on some occasions. Table 9 summarizes the t-test results for the differences in mean of artifact classes by sex in single burials. Collective burials are excluded from the test because many of them contain interments of mixed sexes, and it is usually ambiguous to whom a particular artifact was offered. Because of the small sample size and low occurrence of many of the artifact classes, we view the significance level as an exploratory measure for the identification of potential significant differences. We use 0.15 as the cut-off point. When an artifact class has a significance level smaller than 0.15, we will further examine the distribution of that particular class of offering.

Phase II is a good place to start because it has the highest frequency of burial goods. Six of the artifact classes of this phase have significant levels smaller than 0.15. They include apparel adornments, bone material, hunting and fishing tools, bone flutes, two-pronged bone implements, and turtle shells. We then further examine the distribution of these six artifact classes with stem-and-leaf plots.

Stem-and-leaf plots are a visual method of displaying the distribution without losing the details of the data. Figure 12 has the stem-and-leaf plots of the six artifact classes by phase and by sex. Only the single graves that yielded interments identified to sex and yielded at least one count of the artifact class in question are

TABLE 9. PROBABILITIES OF TWO-TAILED TEST FOR EQUALITY OF MEANS (*t*-TEST) OF THE FREQUENCIES OF ARTIFACT CLASSES BETWEEN MALE AND FEMALE SINGLE BURIALS, JIAHU

| ARTIFACT CLASS | PHASE I | PHASE II | PHASE III | ALL PHASES |
|---|---|---|---|---|
| Pottery vessels | .34 | .68 | .48 | .83 |
| Stone tools | .56 | .33 | .74 | .48 |
| Adornments | .02 | .11 | — | .27 |
| Bone materials | — | .10 | .46 | .12 |
| Hunting/fishing tools | .28 | .02 | .23 | .02 |
| Bone needles | .88 | .51 | .09 | .88 |
| Bone domestic tools | .80 | .77 | .42 | .48 |
| Bone flutes | .49 | .14 | .46 | .10 |
| 2-pronged implements | .34 | .14 | — | .10 |
| Animal mandibles | .49 | .52 | .46 | .45 |
| Turtle shells | .44 | .09 | — | .08 |
| All symbols | .29 | .07 | .30 | .04 |
| Total | .75 | .01 | .35 | .05 |
| Degree of freedom | 37 | 106 | 94 | 241 |

used. Because of the tentative nature of the t-test results (we use a nontraditional significant level), we need to examine the details of the distribution and look for consistent patterns through time. Let us begin with a discussion of the distribution of personal adornments.

Only one phase III burial, M274, a juvenile individual not identifiable to sex, yielded a perforated stone pendant. Therefore, no stem-and-leaf plot is produced for phase III. During phase I, a total of eight graves yielded apparel adornments as burial goods. They were evenly distributed by sex; four male and four female graves bore adornments. Each of the four male graves bore one count of adornment, making a mean at 1. The four female graves yielded two, three, five, and ten adornments, making a mean at 5.00 ($n = 4$, mean = 5.00). Given that the male:female ratio for phase I is 0.659:0.341, we therefore expect to see a ratio of 5.27 male versus 2.73 female graves bear adornments if the distribution of adornments is a random process. The combination of a slightly higher than expected number of female adornment-yielding graves with more adornments than their male counterparts gives a significance result in the t-test ($p = 0.02$, Table 9).

Nevertheless, the pattern changes in phase II. More male burials (9) yielded adornments than female burials (3), and the male burials yielded a higher mean (1.78) than that of the female burials (1.00). There exists a disparity between the distributional patterning of apparel adornments in phase I and phase II. This inconsistency in the distribution of apparel adornments among male and female graves makes us skeptical about the implication of the t-test results. It is inconclusive if sex had an effect on the offering of apparel adornments to the deceased in Jiahu's cultural practice. If these ornaments were parts of the apparel worn by the deceased coincidental to the events of death, it is unclear if decorative apparel was sex sensitive.

In contrast to the distribution of adornments, the distribution of bone flutes is consistently favorable to the male. During phase II, seven male burials were

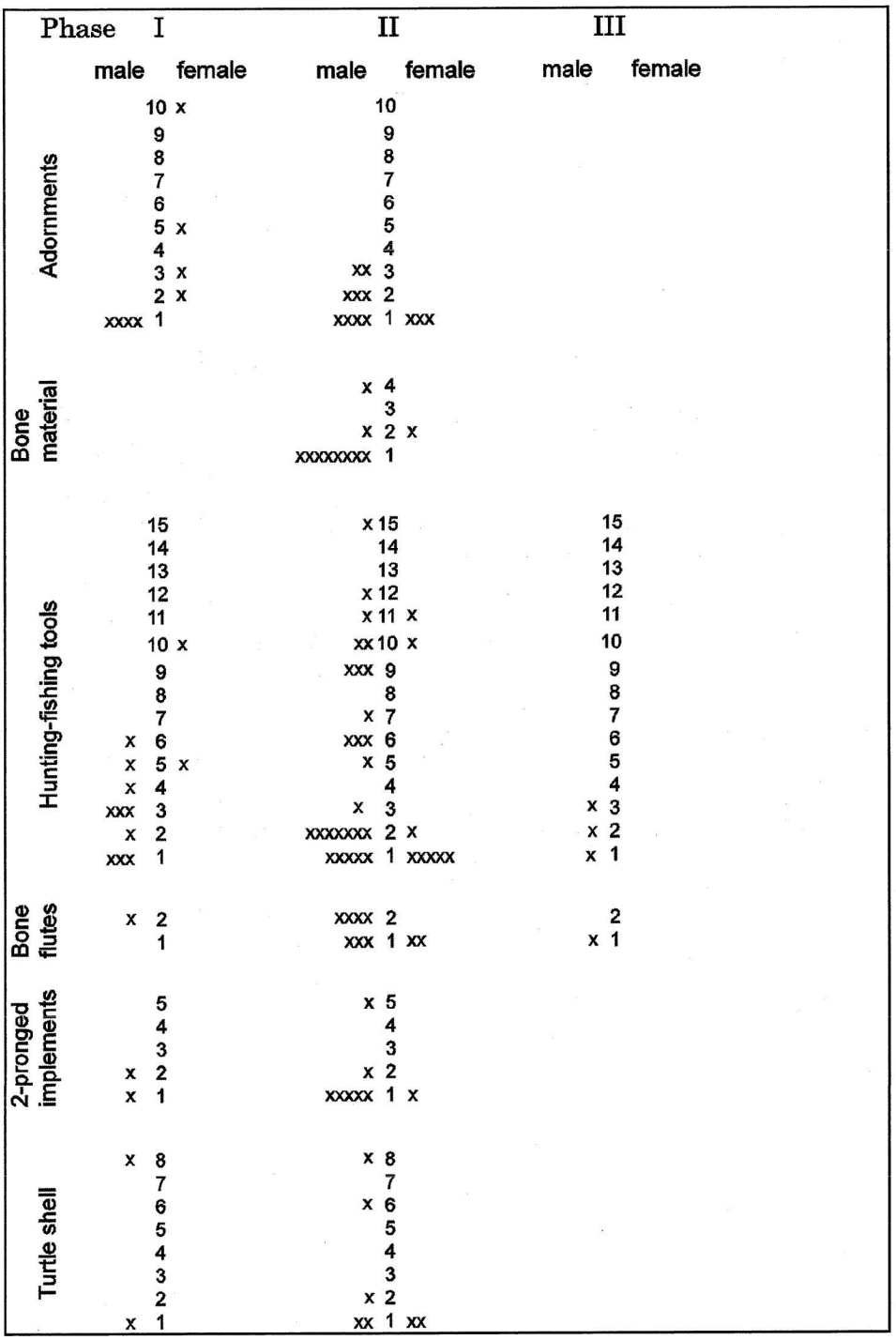


Fig. 12. Stem-and-leaf plots of the distribution of artifact classes by sex.

offered bone flutes, and four of them had two flutes, whereas only two female burials yielded the artifact. Two phase I and III burials yielded bone flutes, and they were all identified as to males.

In the same way, we argue that there exists a bias in favor of the male in the distribution of hunting-fishing tools, two-pronged bone implements, and turtle shells. The distribution of bone material, although showing a strong pattern during phase II, remains questionable because no bone material was found in the single burials of the other two phases. As a result, no comparative patterns are available. In sum, flutes, two-pronged implements, turtle shells, and hunting-fishing tools were very likely sex-sensitive burial goods in the Jiahu community.

The differential treatment by sex can also be monitored from the results of cluster analysis. As discussed above, the cluster analysis partitions the burials into a vertical order of common and prestigious burials. The common burials are further grouped into two different clusters, 1 and 2. First, we test if the percentages of males buried in the prestigious graves are different from that of the females. Again, we use only the single burials. If male and female interments were treated equally, we expect to see the percentage of males treated in prestigious burials among all males equivalent to that of female prestigious burials.

The lower part of Table 10 shows that the only significant difference occurs in phase II. Ten out of the 55 male burials are classified as prestigious burials (15.4%). Only one out of 42 female burials is classified as a prestigious burial, a much smaller 2.3 percent. Consequently, the difference of 13.1 percent is statistically significant. On the contrary, the difference in percentage between male and female prestigious burials in phases I and III are so small that they are not statistically significant.

In addition, we hypothesize that if the difference between the lower order of common burials, that is the difference between clusters 1 and 2, is attributable to sex, there should exist a dichotomized distribution of males and females in these clusters. Simply, we should see male interments distributed in one of the clusters, with female interments in the other cluster. The upper part of Table 10 deviates significantly from our expectation. Therefore, the difference between cluster 1 and cluster 2 must have been regulated by factors other than sex.

TABLE 10. BURIAL CLUSTER BY SEX, SINGLE BURIALS, JIAHU

| | PHASE I | | PHASE II | | PHASE III | | ALL PHASES | |
|---|---|---|---|---|---|---|---|---|
| BURIAL CLASS | MALE | FEMALE | MALE | FEMALE | MALE | FEMALE | MALE | FEMALE |
| Cluster 1 | 11 | 8 | 39 | 35 | 28 | 22 | | |
| Cluster 2 | 11 | 3 | 16 | 7 | 21 | 9 | | |
| Common | 22 | 11 | 55 | 42 | 49 | 31 | 126 | 84 |
| Prestigious | 4 | 2 | 10 | 1 | 3 | 3 | 17 | 6 |
| Total | 26 | 13 | 65 | 43 | 52 | 34 | 143 | 90 |
| % prstgs | 15.4 | 15.4 | 15.4 | 2.3 | 4.8 | 8.8 | 11.9 | 6.7 |
| p-value[a] | 1.00 | | .01 | | .47 | | .18 | |

[a] p-value of test of equality of two percentages with arcsine transformation, two-tailed test (Sokal and Rohlf 1969:607–610).

TABLE 11. BURIAL CLASS BY AGE, JIAHU

| BURIAL CLASS | PHASE I | | | PHASE II | | | PHASE III | | | ALL PHASES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JNLE | ADLT | OLD | JNLE | ADLT | OLD | JNLE | ADLT | OLD | JNLE | ADLT | OLD |
| Cluster 1 | 2 | 9 | 9 | 9 | 71 | 10 | 2 | 53 | 11 | | | |
| Cluster 2 | 1 | 10 | 4 | 2 | 21 | 7 | 4 | 22 | 8 | | | |
| Common | 3 | 19 | 13 | 11 | 92 | 17 | 6 | 75 | 19 | 20 | 186 | 49 |
| Prestigious | 1 | 4 | 1 | 1 | 12 | 2 | 2 | 6 | 2 | 4 | 22 | 5 |
| Total | 4 | 23 | 14 | 12 | 104 | 19 | 8 | 81 | 21 | 24 | 208 | 54 |
| % prstgs | .25 | 17.4 | 7.1 | 8.3 | 11.5 | 10.5 | 25.0 | 7.4 | 8.5 | 16.7 | 10.6 | 10.2 |
| p-value[a] | .83 | .34 | | .73 | .90 | | .17 | .87 | | .41 | .94 | |

[a] p-value of test of equality of two percentages with arcsine transformation, two-tailed test (Sokal and Rohlf 1969:607–610).

Besides sex, age is another important biological parameter used in monitoring past social organizations (Peebles and Kus 1977). From Table 11 it is clear that all the clusters contain individuals of different ages. Juveniles and old individuals have small sample sizes. Their percentages are tested only against that of the adults. None of the tests shows that the differences in percentage are statistically significant.

We also investigate the distribution of the diagnostic artifact classes that are important in the definition of prestigious burials (Table 12). It seems that all these artifact classes distribute across the age groups; however, two-pronged bone implements and turtle shells have never been found in juvenile burials. Given the low occurrence of juvenile burials and the low frequency of these two artifact classes at Jiahu as a whole, this is not a strong pattern.

Three juvenile burials are quite intriguing. Burial M99, containing a child aged 13–15, was offered a bone flute. Burial M41, the grave of a young individual tentatively identified as female who died sometime between 12–15, was offered five bone harpoons, along with 11 other artifacts. The single interment of M291 was tentatively identified as female younger than 17; she was offered nine bone arrowheads and one bone harpoons. These three cases not only show that younger members of the Jiahu community were treated well upon their death, but it

TABLE 12. PRESENCE OF BURIAL GOODS BY AGE, JIAHU

| BURIAL GOODS | JUVENILE | ADULT | OLD |
|---|---|---|---|
| Hunting/fishing tools | 4[a] | 42 | 11 |
| Bone flute | 1 | 10 | 2 |
| 2-pronged implement | 0 | 8 | 4 |
| Animal mandible | 1 | 5 | 2 |
| Turtle shell | 0 | 11 | 3 |
| All symbols | 2 | 19 | 6 |
| Total burials | 24 | 207 | 55 |

[a] Number of burials.

also challenges us to decipher the cultural meaning as to why they were buried with a bone flute, an apparently special and very likely prestigious symbol, and large numbers of hunting and fishing tools.

To summarize, the biological parameters of sex and age did not seem to play important roles in determining how individuals were treated upon death. Although the sex ratio is biased against females, they are proportionally represented in treatment types that necessitate more effort, such as collective burials. They are also proportionally represented in the two larger clusters of the common order. It is also apparent that people of all ages were treated similarly, except for the infants and very young children, who were disposed of in urns. It is noteworthy to point out that children in their teens were treated as adults. Some teens were offered with prestigious symbols and large quantities of hunting and fishing tools. However, female burials were less often offered with the prestigious symbols of bone flutes, two-pronged bone implements, and turtle shells. Consequently, females are underrepresented in the higher order burials, particularly during phase II.

## SPATIAL PATTERNS OF MORTUARY TREATMENT

The spatial dimension of formal disposal area is a critical component of mortuary practice. A community may regulate the degree of structure and spatial separation and ordering of the disposal area. Status differentiation, family groups, descent groups, or special classes may relate to the spatial relationship of the graves (Goldstein 1981).

The present excavation reveals that in each of the three temporal phases of Jiahu, graves were partitioned into two to six spatially discrete formal disposal areas (Table 2). However, excavation of many of the graveyards is incomplete because their boundaries have yet to be found. In the following, we focus only on the comparison of the disposal areas that appear to have been fully uncovered. They are areas Ya and Yb of phase I, Ea and Eb of phase II, and Sa and Sb of phase III. Among them, we concentrate on area Ea and area Eb. These two graveyards comprise a considerable number of burials, show intriguing spatial patterns, and display significant variation in grave treatment.

Areas Ea and Eb of phase II were located about 35 m from each other. They shared intriguing similarities in distribution despite the fact that they were different in shape (Figs. 6 and 7). The graves were densely distributed in the center of the disposal areas. In several instances, up to five graves in the center would overlap and cut into one another. The distributions gradually thinned out to the periphery and clearly defined the borders of the disposal areas as the distributions discontinued. Male and female interments were randomly distributed, whereas secondary burials tended to locate in the center of the disposal areas.

It seems that the burials were partitioned into spatial groups smaller than the graveyards. They were distributed in close proximity, spatially separated from the other graves, sometimes sharing unique mortuary features. The clearest example of a smaller group in area Ea were graves 319, 315, 314, and 293 located in the eastern half of grid square T102. These graves were dug side-by-side and three out of four of the interments had the limbs removed. For area Eb, graves 62, 95, 100, 119, 120, 121, 124, and 127 in T9 were spatially defined and stand in opposition to the group in T8, which contained graves 69, 72, 81, 82, 83, 84, 85, 86,

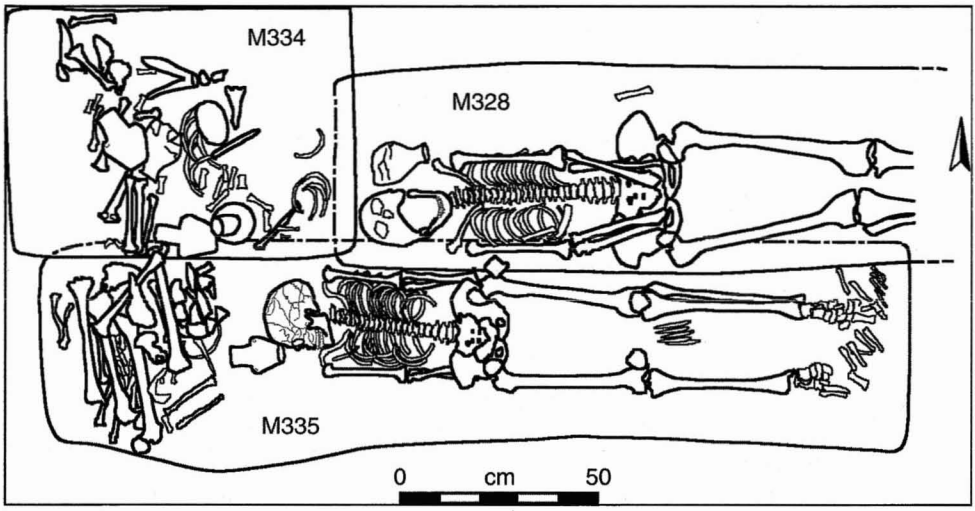


Fig. 13. Stratigraphic relation of graves M328, M334, and M335.

87, 88, 90, 92, 91, 98, and 128. In addition, graves 59, 65, 93, 101, 102, 105, 115, and 123 in T10 and T23 formed another spatially defined group.

These smaller spatial groups were not only located in close proximity, they often cut into each other. We argue that they were intentionally arranged in the constrained space as a strategy to project an image of collective group identity. Figure 13 shows the relationship of three phase II graves located in T102. Grave M335 was dug first. It contained the primary burial of a male at the age of about 25 interred in the extended supine posture, and a secondary burial of a male adult with his remains placed unarticulated to the west of the primary interment. Grave M328 was then dug parallel to the north of the primary interment of M335 and its south wall cut into the north wall of the previous grave. This earthen grave contained a primary skeleton identified as a male about 35 years old interred in the extended supine posture with both hands on his hips. Finally, pit M334, which contained the secondary interments of a "middle-aged" male and an "old male," was dug to the west and cut into the other two graves. To dig the burial pits so close, but only slightly overlapping and cutting into previous graves indicates that these were most likely planned acts with the goal of placing the dead of shared social relations next to each other.

Other than burying the deceased in spatial proximity, the Jiahu people also used the strategy of collective burial and circulation of body parts in the living community to promote group solidarity. Collective burials that involved secondary interments were a funeral rite of multiple phases. It included a phase of body treatment to remove the soft tissue. Although the exhumed empty graves at Jiahu might have been used as facilities to allow the soft tissue to decompose naturally, the considerable discrepancy between the number of exhumed graves and the number of secondary interments indicates that the Jiahu people might have had other procedures to deflesh the corpse, in which we have no archaeological evidence.

Collective burials not only physically contained the remains of the deceased

members of a group. They minimized the social identities of the individual dead and magnified them as members of the group. At the same time, phases of secondary funeral rites occurred over time intervals spanning years. Secondary funeral rites were indeed social memory in action. The deceased would be remembered as members of a group long after they were gone. Secondary funeral rites are acts of cultural drama that would have affected the lives of the participants as well as the observers.

Furthermore, the rite of severing and removing body parts from the corpse during the funeral rite may have also been a social memory strategy of the Jiahu people. We do not have conclusive evidence on how the severed bone elements were used. As discussed above the right mandible found in M282 could have been circulated in the living world before it was eventually disposed of as an offering. The body part of a dead person might serve as a medium to evoke memory and emotion, and may be used as paraphernalia to cross over from the living world to afterworld.

Death is a crisis that interrupts society. The Jiahu people used the funeral rite to assist them toward a transition into a new stage in the absence of the deceased. The moment of death was not only related to the process of afterlife, but also to the processes of living, aging, and producing progeny (Metcalf and Huntington 1991:108), particularly the progeny that constituted the social group in the midst of a crisis of losing one of its member to death. Given that these smaller spatial groups comprised no more than a couple dozen interments, they likely correspond to family or extended family groups. The spatially discrete formal disposal areas, comprised of a few family or extended family groups, were likely the graveyards of lineage groups.

We also monitor the similarities and differences of the mortuary treatment of disposal areas, or lineage groups, through burial type, body posture, and burial goods. First, we compare the burial type (single versus collective burials) and posture of the interments of the disposal areas by temporal phase (Table 13). The composition of burial type and body posture of areas Ya and Yb during phase I, and that between Sa and Sb during phase III are very similar. The test of equality of the paired percentages indicates that their differences are significant at the 0.20 level and lower (Table 14). In contrast, the composition of burial type of areas Ea and Eb of phase II show marked difference. The tests are statistically significant at the level of 0.04 for burial type and the extended prone body posture. It is apparent that area Ea has a significantly higher percentage of collective burials, and consequently a lower percentage of single burials, than that of area Eb. It was rare to bury the Jiahu dead in the extended prone posture, yet, during phase II prone burials were exclusively distributed in Ea.

The spatially discrete disposal areas are then tested against the cluster results. The distribution of the three clusters is cross-tabulated with the disposal areas (Table 15). Only one of the paired percentages is statistically significant. That is to say, the common burials of clusters 1 and 2, as well as the prestigious burials were more-or-less evenly distributed across the paired areas. The only exception is that of phase II; area Ea had considerably more cluster 2 burials and fewer cluster 1 burials, and the difference is statistically significant.

We then further investigate the differential distribution of artifact classes by areas Ea and Eb of phase II (Table 16). Area Ea had a much higher mean in pot-

TABLE 13. DISTRIBUTION OF BURIAL TYPES AND BODY POSTURE BY DISPOSAL AREAS, JIAHU

| | PHASE I | | PHASE II | | PHASE III | |
|---|---|---|---|---|---|---|
| BURIAL TYPE/BODY POSTURE | AREA YA | AREA YB | AREA EA | AREA EB | AREA SA | AREA SB |
| Single | 25[a] | 15 | 55 | 47 | 60 | 32 |
| | 96.2[b] | 100.0 | 70.5 | 85.5 | 88.2 | 88.9 |
| Collective | 1 | 0 | 23 | 8 | 8 | 4 |
| | 3.9 | — | 29.5 | 14.5 | 11.8 | 11.1 |
| Total | 26 | 15 | 78 | 55 | 68 | 36 |
| Primary extended supine | 17 | 12 | 51 | 26 | 49 | 25 |
| | 65.4 | 75.0 | 43.2 | 42.6 | 68.1 | 64.1 |
| Primary extended prone | 3 | 2 | 3 | 0 | 0 | 0 |
| | 11.5 | 12.5 | 2.5 | — | — | — |
| Secondary | 2 | 1 | 52 | 25 | 17 | 8 |
| | 7.7 | 6.3 | 44.1 | 41.0 | 23.6 | 20.5 |
| Element removed | 3 | 1 | 9 | 9 | 4 | 5 |
| | 11.5 | 6.3 | 7.6 | 14.8 | 5.6 | 12.8 |
| Relocated | 1 | 0 | 3 | 1 | 2 | 1 |
| | 3.8 | — | 2.5 | 1.6 | 2.8 | 2.6 |
| Total | 26 | 16 | 118 | 61 | 72 | 39 |

[a] frequency [b] percentage

tery vessels and the test is significant at higher than the 0.01 level. This result is expected because most burials of cluster 2 yielded more than one pottery vessel, whereas members of cluster 1 had no more than one vessel. The concentration of cluster 2 burials in Ea gives rise to more pottery vessels in this disposal area. Overall, burials of area Ea also have more burial goods than their counterparts in area Eb ($p = 0.04$). Nonetheless, Ea and Eb do not show significant difference in

TABLE 14. TEST OF EQUALITY OF PERCENTAGES OF BURIAL TYPE, BODY POSTURE BY AREA, JIAHU

| | PHASE | | |
|---|---|---|---|
| BURIAL TYPE/BODY POSTURE | I[a] | II[b] | III[c] |
| Single | .23 | .04 | .91 |
| Collective | .23 | .04 | .91 |
| Primary extended supine | .51 | .94 | .67 |
| Primary extended prone | .92 | .04 | — |
| Secondary | .87 | .69 | .70 |
| Element removed | .56 | .14 | .20 |
| Relocated | .22 | .69 | .95 |

[a] p-value of test of equality of two percentages with arcsine transformation, two-tailed test (Sokal and Rohlf 1969:607–610); test between areas Y1 and Y2.
[b] Test between areas E1 and E2.
[c] Test between areas S1 and S3.

TABLE 15. DISTRIBUTION OF BURIAL CLUSTERS BY AREA, JIAHU

| AREA / BURIAL CLASS | PHASE I | | PHASE II | | PHASE III | |
|---|---|---|---|---|---|---|
| | Y1 | Y2 | E1 | E2 | S1 | S3 |
| Cluster 1 | 13 | 8 | 41 | 42 | 40 | 21 |
| Cluster 2 | 10 | 4 | 23 | 8 | 21 | 13 |
| Total | 23 | 12 | 64 | 50 | 61 | 34 |
| % Cluster 2 | 43.5 | 33.3 | 35.9 | 16.0 | 34.4 | 38.2 |
| p-value[a] | .76 | | .02 | | .72 | |
| Common | 23 | 12 | 64 | 50 | 61 | 34 |
| Prestigious | 3 | 3 | 14 | 5 | 7 | 2 |
| Total | 26 | 15 | 78 | 55 | 68 | 36 |
| % Prestigious | 11.5 | 20.0 | 17.9 | 9.1 | 10.3 | 5.6 |
| p-value[a] | .47 | | .14 | | .40 | |

[a] p-value of test of equality of two percentages with arcsine transformation, two-tailed test (Sokal and Rohlf 1969:607–610).

other artifact classes of burial goods. The difference between Ea and Eb is more likely to be a horizontal difference rather than a vertical difference.

The above analysis points to possible differential treatment of the single and collective burials during phase II. Indeed, collective burials consistently yielded higher means in burial goods of utilitarian functions (Table 17). However, they appear to have fewer prestigious symbols than their singular counterparts do. Test of equality of the means of the single and collective burials shows that they are highly significant (<0.01) in pottery vessels, apparel adornments, bone needles, bone domestic tools, as well as the total number of grave offerings. Collective

TABLE 16. COMPARISON OF THE MEANS OF ARTIFACT CLASSES AMONG THE BURIALS IN AREAS E1 AND E2, PHASE II, JIAHU

| ARTIFACT CLASS | MEAN | | t-TEST |
|---|---|---|---|
| | AREA EA | AREA EB | p-VALUE[a] |
| Pottery vessels | 1.49 | .80 | .00 |
| Stone tools | .29 | .31 | .93 |
| Adornment | .27 | .16 | .33 |
| Bone material | .26 | .31 | .76 |
| Hunting/fishing tools | 1.94 | .75 | .08 |
| Bone needle | .95 | .33 | .27 |
| Domestic tools | 1.18 | .64 | .12 |
| Bone flute | .12 | .09 | .74 |
| 2-pronged implement | .08 | .05 | .68 |
| Animal mandible | .08 | .16 | .46 |
| Turtle shell | .56 | .20 | .21 |
| Total symbols | .83 | .51 | .44 |
| Total burial goods | 7.2 | 3.8 | .04 |
| No. of burials | 78 | 55 | |

[a] Test of the equality of two means, two-tailed.

TABLE 17. TEST OF EQUALITY OF MEANS, SINGLE BURIALS VERSUS MULTIPLE BURIALS, PHASE II, JIAHU

| ARTIFACT CLASS | BURIAL TYPE | | t-TEST p-VALUE[a] | WT. MEAN[b] | t-TEST p-VALUE[a] |
|---|---|---|---|---|---|
| | SINGLE | MULTIPLE | | MULTIPLE | |
| Pottery vessels | .90 | 2.36 | .00 | .85 | .78 |
| Stone tools | .28 | .64 | .06 | .27 | .91 |
| Adornment | .16 | .30 | .20 | .14 | .78 |
| Bone material | .12 | .70 | .00 | .23 | .24 |
| Hunting/fishing tools | 1.27 | 1.85 | .41 | .69 | .29 |
| Bone needle | .27 | 1.97 | .00 | .66 | .09 |
| Domestic tools | .60 | 1.85 | .00 | .77 | .46 |
| Bone flute | .10 | .06 | .62 | .03 | .33 |
| 2-pronged implement | .10 | .09 | .95 | .02 | .40 |
| Animal mandible | .09 | .09 | .99 | .03 | .61 |
| Turtle shell | .28 | .64 | .21 | .18 | .69 |
| Total symbols | .56 | .88 | .46 | .27 | .44 |
| Total burial goods | 4.16 | 10.52 | .00 | 3.87 | .78 |
| No. of burials | 134 | 33 | 167 | 33 | 167 |

[a] Test of the equality of two means, two-tailed.
[b] Weighted mean = burial goods per individual of collective burial.

burials, by definition, are burials that contain more than one interment. Yet, we cannot ascertain to whom a specific artifact was offered. We may, however, weigh the offerings to collective burials differently; that is, to divide the number of artifacts of a burial by the number of interments in that burial. This procedure dramatically reduces the means of collective burials to the levels almost identical to that of the single burials. Subsequently, none of the differences between the means of burial goods of single and collective burials is statistically significant (Table 17). Therefore, from the perspective of grave offerings, interments in collective burials were not treated differently from the interments in single burials.

Finally, a total of 37 interments had either the limb bones or the skulls removed. These interments comprise both sexes and among the identifiable interments, 17 are males and 14 are females. These burials do not seem to be treated differently. Table 18 compares the means of burial goods of the element-removed burials to that of the other burials. The differences between them are mostly small and not statistically significant. Nevertheless, the element-removed burials consistently have higher mean values for prestigious symbols such as bone flutes, two-pronged bone implements, animal mandibles, and turtle shells; and the difference of the means of mandibles is significant at the 0.004 level. In addition, when these artifact classes are combined (all symbols), the difference is significant at the 0.02 level. The element-removed burials apparently bore a slightly higher prestige than regular burials.

The burials of Jiahu were spatially organized in a hierarchy of at least three levels. The urn burials and the earthen pit burials were located in separate spaces. The pit burials were partitioned into several disposal areas. Finally, burials in each disposal area were partitioned into smaller spatial groups. This spatial arrangement of the dead was very likely regulated by the organizational principles of the living

TABLE 18. COMPARISON OF THE MEANS OF ARTIFACT CLASSES AMONG ELEMENT-REMOVED BURIALS AND OTHER BURIALS, JIAHU

| | MEAN | | t-TEST |
|---|---|---|---|
| ARTIFACT CLASS | OTHER BURIALS | ELEMENT-REMOVED | p-VALUE[a] |
| Pottery vessels | .81 | .57 | .15 |
| Stone tools | .23 | .35 | .33 |
| Adornment | .17 | .16 | .96 |
| Bone material | .08 | .08 | .97 |
| Hunting/fishing tools | .69 | .84 | .70 |
| Bone needle | .33 | .38 | .89 |
| Domestic tools | .57 | .51 | .77 |
| Bone flute | .04 | .14 | .07 |
| 2-pronged implement | .05 | .11 | .39 |
| Animal mandible | .02 | .24 | .00 |
| Turtle shell | .15 | .46 | .10 |
| Total symbols | .26 | .95 | .02 |
| Total burial goods | 3.18 | 3.84 | .44 |
| No. of burials | 273 | 37 | |

[a] Test of the equality of two means, two-tailed.

world. The similarity of the spatial patterns of the disposal areas, and the interment treatment methods between disposal areas indicate an egalitarian tendency in the Jiahu community.

### *Bone, Diet, Health, and Lifestyle in Mortuary Context*

Chronic infectious disease, iron-deficiency anemia, and degenerative joint disease are three of the most common diseases amongst agrarian populations. When their frequencies are put into the context of the mortuary treatment, they generate some intriguing insights on the dynamics of the funeral ritual and the society that generated the ritual 9000 years ago.

The Jiahu human bone assemblage has a surprisingly low rate of periosteal reaction, only 9 out of 900 bone samples. This rate is contrary to our expectation. In contrast, 8.5 percent of all bones in a study of specimens from the farming community of Shijia, a Yangshao site, show evidence of periosteal reactions (Smith 2005).

Several lines of evidence indicate that the Jiahu people lived in a year-round settlement. They invested heavily in facilities such as house shelter and storage. Their tool assemblages included some heavy stone utility tools, such as milling stones that were quite immobile. Rice was an annual cultigen. In addition to regular farming duties, once harvested, the bulky grains would have tied down the community. Sedentary lifestyle is often cited as a major cause of infectious disease outbreaks, which elevates the rate of periosteal reactions. The increase of population density in a long-term occupation would have undermined the ability of the inhabitants to maintain a sanitary living environment because of the increase in the volume of domestic waste. Like many prehistoric settlement sites in this part of the world, the only waste management program evident at Jiahu disposed do-

mestic trash in abandoned house shelters and storage cellars. The deteriorating sanitary environment would have encouraged the spread of infectious diseases. Therefore, we expected to see a higher rate of periosteal reaction among the Jiahu villagers.

A plausible explanation for the low rate of periosteal reaction is that although the Jiahu people practiced a sedentary lifeway, the population density of the settlement was maintained at a low level. Jiahu is one of the earliest sedentary settlements found in central China. The transition from foraging to agriculture had just been completed. The four dozen or so identified living shelters are small, more than 70 percent of them with occupied living floor of less than 10 $m^2$. It is possible that the population of the settlement at any particular time was small, resulting in a cleaner living environment that inhibited outbreaks of infectious disease.

Alternatively, we may find an answer in the diet of the people. The chemical residue analysis of the potsherds cited above (McGovern et al. 2004) strongly suggests that many of the Jiahu vessels were used for mixed fermented beverages. It seems that the ancient villagers often intoxicated themselves. Regular consumption of alcohol might have been beneficial to their health because it killed many of the bacteria and parasites that caused periosteal reaction (Zhang and Lee 2005).

Unlike periosteal reaction, the Jiahu human skeletal assemblage has a high rate of porotic hyperostosis, a symptom of iron-deficiency anemia. As a whole, nearly 70 percent of the observable cranial specimens show signs of porotic hyperostosis (Table 19). Although we cannot be certain, it is very likely that a heavy-rice low-meat diet triggered iron-deficiency anemia, leading to the frequent occurrence of porotic hyperostosis on the skull vault (Smith 2005).

The rates of porotic hyperostosis at Jiahu were quite uniform through time; the chi-square test of the frequencies of porotic hyperostosis by temporal phases is insignificant. The Jiahu males, however, show a higher rate than the females. Although the males consistently show this higher rate in each of the phases, the chi-square tests are insignificant. When the specimens from all phases are combined, the increased sample size shows that men had a statistically significant higher rate (76.3% vs. 57.8%). We have also compared the rates of porotic hyperostosis between the burials of the various classifications, such as prestigious versus common interments, interments buried in different discrete formal disposal areas, single versus collective burials, and element-removed versus regular burials. The only comparisons to show a statistically significant result is the finding that interments buried in the prestigious graves had a significantly higher rate than that of their

TABLE 19. POROTIC HYPEROSTOSIS BY PHASE, SEX, AND GRAVE STATUS, JIAHU

| CRITERIA | CLASSIFICATION | AFFECTED | UNAFFECTED | TOTAL | %AFFECTED | $\chi^2$ PROB |
|---|---|---|---|---|---|---|
| Phase | I | 18 | 5 | 23 | 78.3 | .168 |
| | II | 40 | 25 | 65 | 61.5 | |
| | III | 29 | 9 | 38 | 76.3 | |
| Sex | Female | 26 | 19 | 45 | 57.8 | .03 |
| | Male | 61 | 19 | 80 | 76.3 | |
| Status | Common | 67 | 36 | 103 | 65.0 | .001 |
| | Prestigious | 18 | 1 | 19 | 94.7 | |

common counterparts. This finding is open to multiple interpretations because the lesions typically develop in childhood and status may develop later in life.

The distribution pattern of porotic hyperostosis among the Jiahu sample has effectively eliminated many of the common causes of iron-deficiency anemia, leaving a high-grain low-meat diet the most likely culprit. Heavy blood loss during menstruation would have affected only the females, but the female sample shows lower porotic hyperostosis rate than the male sample. Chronic parasitic infection most likely would have attacked the population indiscriminately. Moreover, the low rate in periosteal reaction suggests that parasitic infection was not a major health problem for the Jiahu people. Although a marriage system that persistently takes one sex from the outside and sends out the other sex through marriage could have contributed to a sexual difference in genetic-related anemia, it could not explain the differential rates of porotic hyperostosis of the prestigious and common individuals.

Observation on porotic hyperostosis prompts us to rethink the dynamics of the funeral rite, as well as the society, of Jiahu. The higher rate of porotic hyperostosis among the males and prestigious individuals is not what we expected to see. Almost all of the interments of prestigious graves show evidence of porotic hyperostosis on their skull vaults. Our first reaction is that perhaps the symbolic artifacts defining the prestigious graves were not that special in the Jiahu community. However, the cluster analysis has demonstrated that graves yielding these symbols also yielded a greater material wealth comprised of larger numbers of other artifact classes, thus supporting the idea that these symbols were special in the Jiahu mortuary program. A more challenging fact is that some of the so-called prestigious graves are defined by the presence of animal mandible and a large number of arrowheads and harpoons, which are presumably used in hunting and fishing. The common graves have a mean of 0.46 hunting/fishing tools per grave, whereas the prestigious graves have a mean of 2.37, and the difference is statistically significant. Similarly, male burials yielded an average of 0.98 hunting/fishing tool and female burials yielded an average of 0.34. We expect to see prestigious individuals and males to have a diet higher in meat, and consequently a lower porotic hyperostosis rate. Contrary to our intuition, these graves show a significantly higher rate of porotic hyperostosis.

We can think of three potential scenarios that may contribute to the observed porotic hyperostosis pattern in the context of the mortuary variation. First, the meat intake of the Jiahu people was very low and inadequate to prevent the development of iron-deficiency anemia. Although the faunal assemblage of Jiahu comprises a large number of species, and animal mandibles, hunting tools, and fishing tools were recovered from the burials, the proportion of meat in the diet cannot be quantified. We cannot dismiss the possibility that the dietary intake of meat of the Jiahu people was actually infrequent and low. If this is true, it also refutes the general belief that the Jiahu villagers were sustained by a broad-spectrum economy. In addition, it does not take lifelong anemia to develop osteological symptoms of anemia; instead one prolonged episodic of iron-deficiency diet is sufficient for an individual to develop porotic hyperostosis, leaving indelible marks on the skull vault. Although overall the females have a lower rate of porotic hyperostosis than the males, the difference is small and not statistically significant when the sample is broken down into temporal phases. The difference between the porotic hyperostosis rates by sex has been exaggerated. This

scenario, however, has a weakness that cannot explain the differential rates between the prestigious and common individuals.

Second, the decision of grave offerings was independent of status and lifestyle of the individual when he or she was living. It is always the living who bury the dead. They have many opportunities to project an idealized image to mask real social relations. Moreover, the offerings could be gifts to the dead rather than the belongings of the dead. This is a dangerous and demoralizing scenario because it would render mortuary analysis useless in understanding past social relations of the Jiahu. We would argue that although the gift hypothesis is possible, it is likely that at least some of the grave goods were personal belongings of the deceased. These include the apparel adornments coincidental to the death events, which have been adequately discussed above. In at least one example, the two bone flutes from grave M282 are so similar that they were unlikely gifts. Tonal analyses of these two flutes show that they play an almost identical musical scale (Zhang et al. 2004). The first flute was broken into three sections but repaired before being buried. The second flute was intact and showed markings indicating that it was cut from the template of the first one. These two flutes most likely belonged to the individual buried in grave M282. Furthermore, the types and quantities of gifts from mourners and other ceremonial attendees would have been determined by their relationship to the deceased. Gifts should convey some social message, albeit a message not necessarily directly reflecting how the society was structured.

Finally, the observed porotic hyperostosis pattern might have involved a strong egalitarian tendency of the community that redistributed the critical resources procured by individuals to the larger groups. In this scenario, hunting/fishing tools were offered to hunting/fishing specialists; however, the food they procured was shared by the group. The role of a specialized hunter and fisherman did not translate into personal economic gain.

The answer to Jiahu's porotic hyperostosis pattern may not be a simple one. It could be a combination of a number of scenarios and different cases might have different causes of iron-deficiency anemia. A successful fishing specialist might have suffered from an imbalanced diet during childhood. The premature death of the child of a successful hunting specialist might have prompted the father to offer a set of arrowheads to the grave hoping that the child would eventually develop into a good hunter in the afterworld. One thing we are certain is that better burial treatment had no implication for better diet throughout the lifetime of the deceased. If unusual material wealth in the burial meant higher status in the Jiahu community, it was a status earned and not inherited.

Degenerative joint disease, also known as osteoarthritis, is caused by the wear of repetitive mechanical motion on the proximal and distal ends of the extremities. It is positively correlated with the age of the specimens. All things being equal, the older an individual, the more likely he or she develops degenerative joint disease. By the same token, premature development of degenerative joint disease is indicative of unusual physical stress on the body. The locations of degenerative joint disease are clues to the kinds of physical activities that caused excessive damage to the cartilage.

The Jiahu human bone assemblage shows that the mean age of specimens with at least one degenerated joint is 43.3 with a relatively small standard deviation of 7.3. The youngest occurrence of degenerative joint disease occurs in three individuals estimated to be about 27 years old.

TABLE 20. DEGENERATIVE JOINT DISEASE BY PHASE AND BY GRAVE STATUS, JIAHU

| CRITERIA | CLASSIFICATION | AFFECTED | UNAFFECTED | TOTAL | %AFFECTED | $\chi^2$ PROB |
|---|---|---|---|---|---|---|
| Phase | I | 26 | 9 | 35 | 74.3 | .01 |
| | II | 65 | 46 | 111 | 58.6 | |
| | III | 13 | 21 | 34 | 38.2 | |
| Status | Common | 86 | 60 | 146 | 58.9 | .40 |
| | Prestigious | 18 | 16 | 34 | 52.9 | |

Degenerative joint disease affected slightly less than two-fifths of the individuals of Jiahu (Table 20). Nevertheless, the disease rate seems to vary significantly from phase to phase. Phase I had the highest rate and it gradually declined in phase II and phase III. The chi-square test suggests that the difference is statistically significant. This pattern may mean that the lifestyle of the Jiahu people became less physically demanding through time. Yet, both phase I and phase III have small sample sizes: 35 and 34 individuals were studied, respectively. Because of the vagaries of small sample size, we are cautious about the interpretation.

The individuals buried in the prestigious graves did not seem to fare better in degenerative joint disease than the individuals buried in the common graves (Table 20). The prestigious individuals had a slightly lower rate of degenerative joint disease than the common individuals did; however, the difference is not statistically significant. That is to say, the prestigious individuals were involved in equally strenuous activities as the common individuals during their lifetimes.

All the other comparisons of degenerative joints are found to be insignificant except with that of sex. The rate of degenerative joint disease in the males is more than 20 percent higher than that in the females (Table 21). Since degenerative joint disease is a function of age and stress, it is essential to view the rate difference in the context of age structure. Indeed, the Jiahu females had a mean age slightly more than three years younger than that of the males, although the difference is not statistically significant (Table 22). However, the fact that arthritis affected the Jiahu females at a mean age two years younger than that of the male would even out some of the difference. As a result, age does not seem to play an important role in the large discrepancy between the rates of arthritis in the females and males at Jiahu.

The males at Jiahu not only have an overall higher rate of osteoarthritis than the females, they also have higher rates in every joint of the body. Although the differences of the three arm joints are statistically insignificant, the fact that the males consistently had more affected arm joints by at least 10 percent suggests the Jiahu males were likely involved in more physically demanding activities that required upper body strength than the Jiahu females. The differences of the two leg joints examined are more than 20 percent and are statistically significant. It is convincing that the Jiahu males were more involved in physical activities requiring repetitive mechanical motion of the leg.

The most straightforward interpretation of the differential rate of degenerative joint disease between the males and females at Jiahu is that there existed a sexual division of labor. Numerous mechanically stressful activities might contribute to the degeneration of joints. Given our knowledge of the Jiahu lifeway, we can infer some of these activities. One of the possible activities is field tilling.

TABLE 21. DEGENERATIVE JOINT DISEASE BY SEX, JIAHU

| LOCATION | DJD | FEMALE | MALE | $\chi^2$, 2-SIDED |
|---|---|---|---|---|
| All joints[a] | Affected | 25 | 78 | .03 |
| | Unaffected | 32 | 43 | |
| | %affected | 43.9 | 64.5 | |
| Vertebra | Affected | 4 | 12 | .79 |
| | Unaffected | 2 | 5 | |
| | %affected | 33.3 | 70.6 | |
| Shoulder | Affected | 9 | 31 | .18* |
| | Unaffected | 11 | 17 | |
| | %affected | 45.0 | 64.6 | |
| Elbow | Affected | 11 | 34 | .38 |
| | Unaffected | 31 | 56 | |
| | %affected | 26.3 | 37.8 | |
| Wrist | Affected | 7 | 20 | .24* |
| | Unaffected | 8 | 12 | |
| | %affected | 46.7 | 62.5 | |
| Arm[b] | Affected | 18 | 49 | .47 |
| | Unaffected | 26 | 45 | |
| | %affected | 40.9 | 52.1 | |
| Knee | Affected | 11 | 49 | .01 |
| | Unaffected | 27 | 39 | |
| | %affected | 28.9 | 55.7 | |
| Ankle | Affected | 2 | 19 | .05 |
| | Unaffected | 22 | 45 | |
| | %affected | 8.3 | 29.7 | |
| Leg[c] | Affected | 12 | 57 | .00 |
| | Unaffected | 29 | 40 | |
| | %affected | 29.3 | 53.3 | |

[a] Affected = at least one observable joint affected; unaffected = all observable joints unaffected.
[b] Affected = at least one observable joint of the arm affected; unaffected = all observable joints of the arm unaffected.
[c] Affected = at least one observable joint of the leg affected; unaffected = all observable joints of the leg unaffected.
* Fisher's exact test, 2-sided.

The field was most likely tilled with a heavy-duty spade-shaped stone tool at Jiahu. Spades were one of the most frequently found stone tools in the site. Eighty-seven stone spades were recovered, making up 11 percent of the stone tool assemblage. The mechanism to till the field with a stone spade involves push-

TABLE 22. DESCRIPTIVE STATISTICS OF OSTEOARTHRITIS BY AGE AND BY SEX, JIAHU

| | AGE | | | |
|---|---|---|---|---|
| SEX | N | MEAN | STD DEVIATION | t-TEST |
| All female | 40 | 36.8 | 10.8 | .08 |
| All male | 92 | 40.1 | 9.5 | |
| Affected female | 13 | 41.7 | 7.1 | .38 |
| Affected male | 49 | 43.7 | 7.3 | |

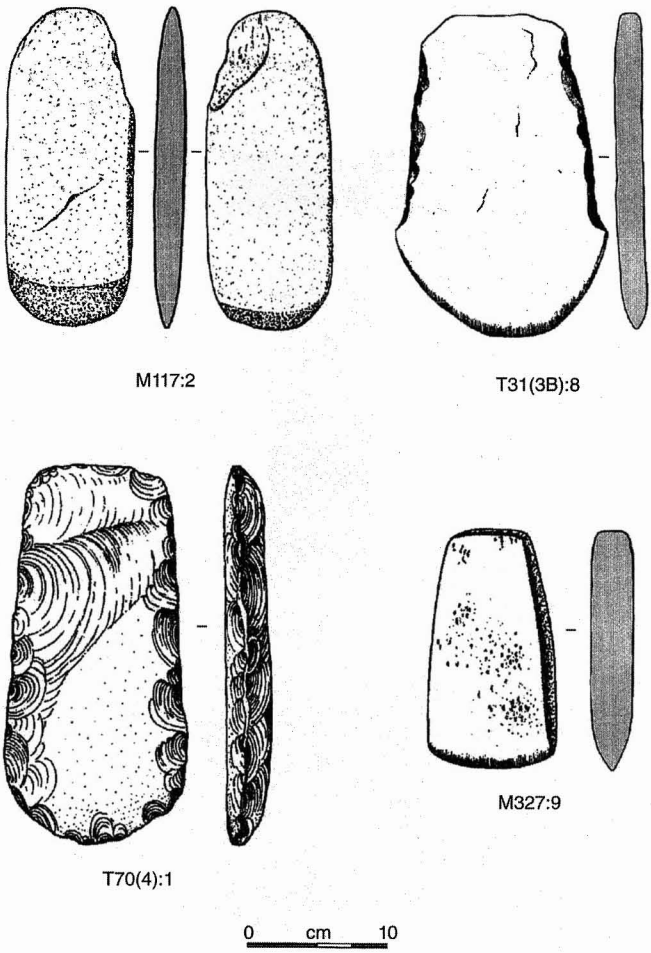


Fig. 14. Typical examples of stone spades of Jiahu (redrawn after Henansheng 1999:362–364).

ing the blade into the soil with a foot stepping on the shoulder of the implement, and then lifting the tool to turn the soil (Li 1995; Wu 2003). It may also involve smashing the chunky earth into smaller bits. Figure 14 shows four examples of the typical morphologies of the Jiahu spades. They were shaped with chipping and grounding technologies and have round blades and rectangular or round shoulders. Their dimensions range from 8.8 to 15.2 cm wide, 17.2 to 27.6 cm long, and 2 to 3.2 cm thick. Some of the specimens show traces pertaining to fastening shafts on the upper bodies. These tillage tools are massive, heavy, and cumbersome. Tilling the field with such tools would have put a lot of stress on the ankle, the wrist, and the shoulder of the farmer, triggering premature development of osteoarthritis in these joints.

Tilling a paddy field is a laborious activity. In modern societies, tilling is primarily done with plough, draft animal, particularly water buffalo, and machinery. Wet rice cultivation requires precise control of water supply to the field in differ-

ent growth stages of the crop. That is to say, it needs constant maintenance of the irrigation channels. Digging irrigation canals with stone spades might have put additional stress on the joints of the Jiahu men. Because of the heavy investment in paddy fields, Jiahu people might have been less likely to shift their fields, thus increasing the demand of field tilling in the farming cycle.

Another possible physically demanding activity that might have contributed to the higher rate of osteoarthritis among the Jiahu males was the medium distance procurement of resources. The large number of arrowheads recovered from the site indicates that hunting was one of the major food procurement strategies of the Jiahu prehistoric community. The faunal assemblage includes animal remains of taxa of deer, boar, marten, leopard, badger, and raccoon. These are mostly woodland animals that can be found today in the piedmont area of the Funiu Mountains, which is within one day roundtrip distance of the site. Moreover, hawthorn is found mostly on hillsides in modern China. Collecting hawthorn fruits for beverage was another physically demanding task. Frequent and regular trips to the mountains would have resulted in excessive wear on the joints of the lower extremities. The higher rates of knee and ankle arthritis among the males suggest that perhaps it was often the males who made such hunting and collecting trips.

## DISCUSSION

Jiahu is a small 9000-year-old early Neolithic sedentary village. The villagers wove a social environment within which they lived their lives and interacted with each other. They mourned the death of their fellow villagers, but they also used the funeral ritual to symbolically and selectively project their social relations. It is easily to be misled if we try to untangle the Jiahu social structure based on the burial data alone.

Human bones document diseases of individuals throughout their lifetime. They are independent of the various stages of the funeral treatment of the deceased. Integrating the pathological study of human remains with the mortuary treatment study can generate a fuller understanding of the social dynamics that structured the prehistoric village community at Jiahu.

We started the study with an exhaustive examination of the variation in material culture remains of mortuary treatment. Based on the quantitative difference of the burial goods, we were able to classify the burial assemblage into a large group of graves furnished with few artifacts and a small group of graves furnished with exceptional material wealth. If we subscribe to the assumption that the mortuary treatment received by an individual is a reflection of that individual as an active member of the society, we would interpret this difference as representing the vertical dimension of the society. The small group of richly furnished graves were burials of the prestigious individuals and their counterparts were that of the common individuals. In addition, we would expect the prestigious individuals of Jiahu would have commanded more resources when they were living, including labor of other people and food sources. Contrary to this expectation, their skeletons show no difference in the rate of osteoarthritis, and a higher rate in porotic hyperostosis when compared to that of their common counterparts. This intriguing contradiction prompts us to rethink the mortuary pattern of Jiahu.

When we sifted through the patterning of the mortuary data again, this time with a different perspective, we gained a new understanding of the social dynamics of Jiahu. The overall difference between grave offerings was a continuum from poorly furnished graves to richly furnished graves, rather than an incremental and stepwise increase. However, the two extremes of the continuum were quite distinctive. Poor graves were unfurnished, whereas rich graves were furnished with several dozen artifacts, including some delicate handicrafts that were labor intensive and required high skill.

The degree of quantitative and qualitative variations of grave furnishings varied through time. The variation was most distinctive during the phase II occupation of the site. In addition, phase II also had the highest proportion of collective and secondary burials, and the highest frequency of delicate handicrafts. If the variation of burial goods was a medium of competitive expression of status and status aspiration, phase II represents a period of increasing ostentation that undermined the egalitarian principle of the society, whereas phase I and phase III represent periods of relative restraint where egalitarianism gained the upper hand.

The social positions of the individuals receiving rich burial treatment did not seem to be prescriptive because surprisingly they had a higher rate of porotic hyperostosis, suggesting that they had suffered from an iron-deficient diet for a prolong period at least once in their lifetime. They had a rate of osteoarthritis similar to that of the common individuals, suggesting that they were equally engaged in physically strenuous labor. It is more likely that the special treatment at death was earned with personal achievements. Moreover, the richly furnished burials were not concentrated in any of the disposal areas, but randomly distributed. The social units actively participated in the social competition of funeral expenditure were individuals or families, not the kin-based groups represented by the disposal areas.

Having said that there existed social competition in mortuary practice, we have to reiterate that the competition occurred in an egalitarian context that access to critical resources in the living community was not differential. In addition to the pathological data, the above contention is also supported by the distribution of material wealth in the cemeteries. *Hu*, the most popular burial goods, were found in graves of different disposal areas, age and sex groups in small number. No hoarding of the vessel was evident, even for the so-called prestigious graves. If we are correct that *hu* were used to contain the alcoholic beverage fermented from food surplus, food surplus was quite equally distributed regardless of social affiliation and status.

After seeing the discrepancy between the material wealth deposited in the graves and the pathological pattern of the skeletons of the same graves, one could jump to the conclusion that the mortuary treatment of Jiahu was a pure projective symbolic system that did not have connection with the social status of the deceased. This would be an error in the other extreme. The differential mortuary treatment between sexes and their pathological pattern well illustrate the misreading of evidence.

The Jiahu females were treated differently than the males, a fact we can attribute to a sexual division of labor. Female bones show a lower rate of osteoarthritis. They were less likely than the males to engage in physically strenuous tasks. This is an indication of a sexual division of labor. The female samples also show a

lower rate in porotic hyperostosis, indicating they were less likely to suffer anemia due to an iron-deficient diet, even though they were biologically more susceptible to anemia.

The females made up only about one-third of the earthen grave burial sample. This sex ratio deviated significantly from the sex ratio at birth. Moreover, symbols such as bone flute, turtle shell, animal mandible, and two-pronged implement were rarely offered to females. *Hu* were more-or-less evenly distributed in the graves, suggesting the females and the males had equal access to the mixed fermented beverage. Fewer burial goods in graves should not be understood as derogative treatment. Organic offerings might have left no trace in the archaeological context.

Finally, the mortuary analysis also suggests that the Jiahu villagers had their unique ways to deal with the critical crisis of death. Death interrupts the existence and continuation of social groups. Funeral ritual itself is an act to counter death, which helps the community starting the transition into a new stage without the participation of the deceased. Yet, the Jiahu people took further steps to counter this social crisis; in fact, they viewed death as an opportunity to extend social memory. Two strategies can be extrapolated from the archaeological records.

First, the Jiahu people might have circulated the body parts of the dead in the living world to evoke emotions about and memories of the dead. Slightly less than 10 percent of the human skeletal sample had bone elements removed. These interments were often treated more elaborately than the other interments, indicating that they were more deserving individuals in the eyes of the Jiahu people. We have no evidence of how the elements were used in the living world. However, it is reasonable to speculate that they were used as paraphernalia to evoke the memory of the deceased individuals.

Second, they prolonged the funeral rite by a strategy of collective burial that involved secondary interments. The skeletons of several individuals who died at different times were collected and placed together in one earthen pit. This strategy required various stages: maintenance, defleshing, and the final burying rite. In the process, social memory was translated into performances that people had to take action and be seen. Intriguingly, most of the collective burials occurred in phase II, and competitive display of mortuary practice was also most intensive in phase II. Perhaps phase II was a time when families were more engaged in funeral competition.

## CONCLUSIONS

Funeral ritual is a projective symbolic system. The funeral treatment received by a deceased individual is not necessarily an honest reflection of his or her social status. Using the material remains recovered from graves to reconstruct social relations among the dead when they were active members of the society is inherently constrained. Human skeletal remains unearthed along with the material culture remains are sources of information independent of the funeral ritual. They document the lifelong health and lifestyle of the deceased. By creating a dialogue between these two different classes of information, we gain intriguing insight into the social dynamics of the Jiahu community known only through archaeological excavation.

We have demonstrated in this article that social reconstruction based on analyses of material remains of funeral treatment, and human bones recovered from the same burial pits, complement each other. Integrating the two classes of information facilitates a fuller understanding of the past society in question. This hybrid methodology has wide applicability in using materials recovered from the mortuary context for the reconstruction of past societies in other parts of the world.

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ABSTRACT

Funeral ritual is a projective symbolic system where the treatment received by a deceased individual does not necessarily reflect the social position of that individual when living. Study of past social relations based on mortuary treatment alone is potentially ambiguous. Because many diseases leave indelible marks on the skeleton, human bones provide independent information reflecting the health and behavior of the deceased. Integrating the studies of mortuary treatment and osteological pathology can achieve a fuller understanding of past societies. Equipped with this hybrid methodology, we tried to unravel the social relations of an early Neolithic community at Jiahu in central China. The considerable difference in the quantity and quality of grave offerings indicates the presence of competitive display in funeral practice. However, the individuals buried in richly furnished graves had higher rates of iron-deficiency anemia than those buried in poorly furnished graves, indicating that higher status at death was not inherited but achieved. Osteoarthritis rates in the females were lower than that of the males, suggesting that they were less engaged in mechanically stressful activities. This sexual division of labor is reflected in a differential mortuary treatment in that fewer females were buried in the communal graveyards and their graves were furnished with less material wealth. Yet, the females had lower iron-deficiency anemia rates, suggesting that playing a physically less strenuous role did not hinder their access to critical resources such as meat in the diet. KEYWORDS: China, mortuary practice, pathology, social reconstruction, projective ritual.